Engineering News

Vol. 67, No. 11. 505 Pearl Street, New York March 14, 1912.

The Dry-Dock at Ashtabula Ohio

By E. C. Bowen, Jr.*

The dry-dock here described, was built during the seasons of 1910-1911 at Ashtabula, O., for the Great Lakes Engineering Works, ship builders, Detroit, Mich. The dimensions of the dock are as follows: clear width on top at entrance or portal, 78 ft.; clear width of dock proper, 102 ft. on top and 85 ft. on bottom; depth of water over sill, 16 ft.; batter of side walls, 3 on 1; length of dock, 636 ft.; length of portal or entrance, 36 ft.

The dock was designed by Mr. A. V. Powell, Consulting Engineer, of Chicago, Ill., who had general supervision of the work. His Resident Engineer, Mr. George Cole, was in local charge of the construction. The contractor was the Inland Waterways Co., of Ashtabula, O., the work being under the active management of Mr. D. McLennan, (Treasurer) and the writer (President), who took the field in person.

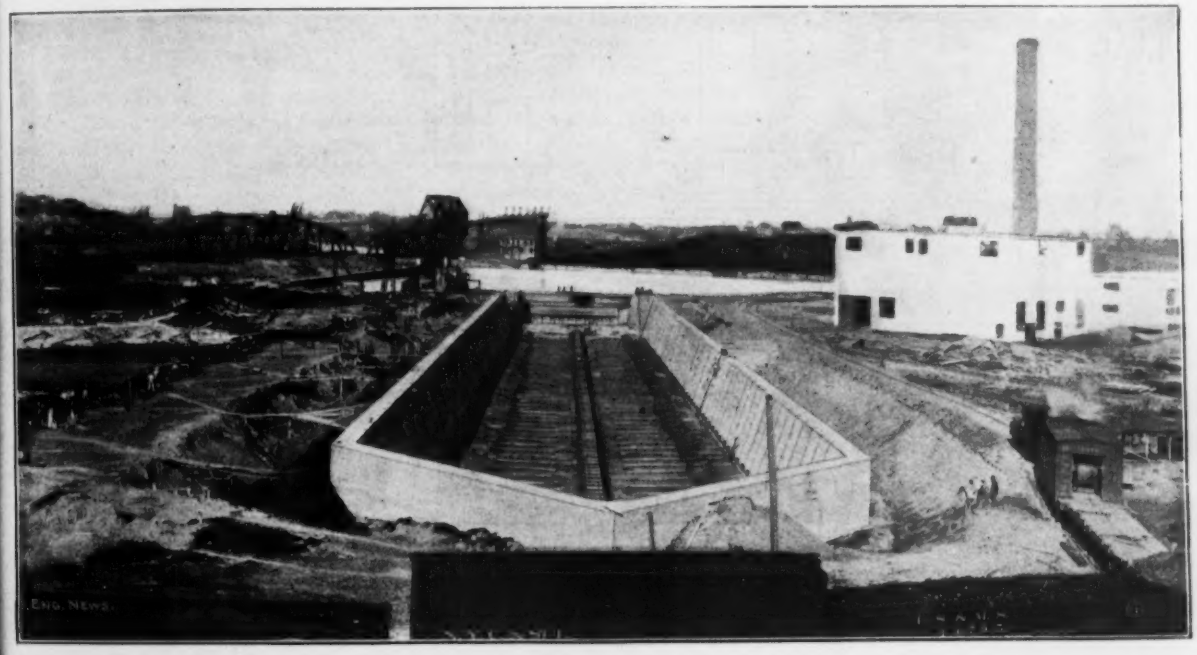
*President, the Inland Waterways Co., Ashtabula, O.

The dry dock, including the portal, is of mass concrete construction, the mixture being 1:3:5. The foundation is shale rock. The drawings Figs. 1, 2 and 3, show the general dimensions, the concrete walls, etc. The floor is of 3-in. white oak plank, supported by 10x10-in. white oak floor beams which are imbedded in concrete cross walls. These walls are 2 ft. thick, and rest on bed rock, as shown in Figs. 2 and 3. A concrete drain runs the entire length of the dock. The general features of the pump well, rudder well, tunnels, etc., are shown on the plan, Fig. 1.

General Scheme for Construction

Adjacent to the portals of the dock, a turning basin was dredged. Before dredging this, the natural surface of the ground was about 3 ft. above lake level. It was planned to carry out the construction as follows: (1) to excavate the pit for the portal concrete in the dry; (2) to place this concrete and build the steel gate for the dock, doing this work simultaneously with that of dredging the turning basin in front of the dry dock and getting it done before the dredging reached the site of the portal; (3) to pass a dredge through the portal and make the excavation for the dry dock in the wet; (4) to place the steel gate in position and pump out the slip thus dredged for the dry dock; (5) to place the concrete for the dock, and also place the timber floor beams, keel, bilge, and scow blocks, and floor planking; (6) to backfill the space on the outside of the dock walls.

In constructing the portal, it was extended sufficiently for two dry docks, side by side, as shown in Fig. 1. The advantages of this construction scheme were (1) taking advantage of the superior rapidity and economy of dredging in the wet over that of steam shovel work in the dry, in doing the main body of the excavation; (2) the portals having been built in the dry, and the steel gate made, this permanent work was thereby used as a cofferdam in pumping out the slip preparatory to building the dock, thus eliminating the expense of temporary structures for this purpose.



The Completed Dry Dock at Ashtabula, Ohio

(At the right is the power house for the two docks and the shipbuilding plant. The men at the left are starting to excavate for the second dock, and the excavated material is being used as backfilling around the first dock.)

Construction of the Portal Pit

The excavation for the portal pit was done with a 40-ton Thew steam shovel and 2-yd. dump cars. On account of the small size of the pit (280x80 ft.) and its depth (26 ft. below level of ground) it was found impracticable to operate more than a single track in removing the excavated material. This was owing to the necessity of carrying on the operation of drilling and blasting the rock simultaneously with that of the steam shovel. This track branched out into a "Y" just outside the pit, so that while a train of loaded cars was being hauled out of the pit, a train of empties was waiting on a leg of the "Y" to descend to the steam shovel, as soon as the loaded cars passed the switch of the "Y". The empties descending into the pit, overhauled the traction cable.

Drilling was first done with steam tripod drills, but on account of the limited size of the pit and the many operations carried on in it, this method was displaced in favor of hand drilling. Blasting was done with 40% dynamite. A constant seepage occurred, and the water was removed by two Emerson pumps with 3-in. discharge, and one 6-in. centrifugal pump. The work of hewing out water stops, bottoms of tunnels, pump well, etc., in the rock, had, from the nature of the work, to be done by hand. The work was commenced on July 1, 1910 and was finished Dec. 1, 1910, during which period there were excavated 6400 cu.yd. of earth and 11,730 cu.yd of rock.

As soon as one-half of the portal pit had been put in finished condition, the work of building the forms and placing the concrete for the portals was started. The concrete was placed by the gravity method, a tower 75 ft. high being built centrally with the work. A Ransome 1½-yd. mixer was used, with storage bins overhead for sand and crushed stone; the bins were fed by a 1-yd. clamshell bucket which was operated by a guy derrick. The concrete was hoisted with a 40 cu.ft. elevator bucket and delivered in place by inclined galvanized iron troughs suspended from cables. On account of the lateness of the season, an auxiliary mixer was subsequently placed on the job to hurry the work along. The mixture was 1:3:5. The cement was furnished by the New Castle Portland Cement Co.; the sand came from Lake Erie in the vicinity of Ashtabula; the crushed stone was furnished by the Kelley Island Lime & Transport Co. The work was commenced Nov. 10, 1910, and was completed Dec. 31, 1910, during which period 5800 cu.yd. of concrete were placed. A dry pit was maintained by the above mentioned pumps. Work was then suspended for the winter.

Dredging and Pumping Out the Slip for the Dry Dock

The excavation for the dry dock was done with a dipper dredge having a rock dipper of 6 cu.yd. capacity. Rock (shale) was excavated without blasting. Earth and rock were dredged simultaneously, the work being carried to grade in one operation. The side slopes in earth were excavated 1 on 1 so as to eliminate the necessity of any sheet pile revetments to keep the banks from caving in after pumping out the slip. This dredging work was sublet to the Edward Bros. Dredge Co. which used the dredge "Majestic"*. The work was commenced March 15, 1911, and was finished May 15, during which period 70,000 cu.yd. of earth and 8500 cu.yd. of rock were removed.

Before closing the gate and pumping out the slip thus excavated, a pile pier was driven with a floating pile driver, as shown on the plan of plant layout, Fig. 4. This pier was 16 ft. wide and long enough to extend out into the slip a comfortable distance beyond the toe of the slope of the bank; it was well anchored into the bank. The piles were capped and the top of the pier planked with 6x12-in. timbers. On this platform were installed two direct-connected, horizontal, centrifugal pumps (one 8-in. and

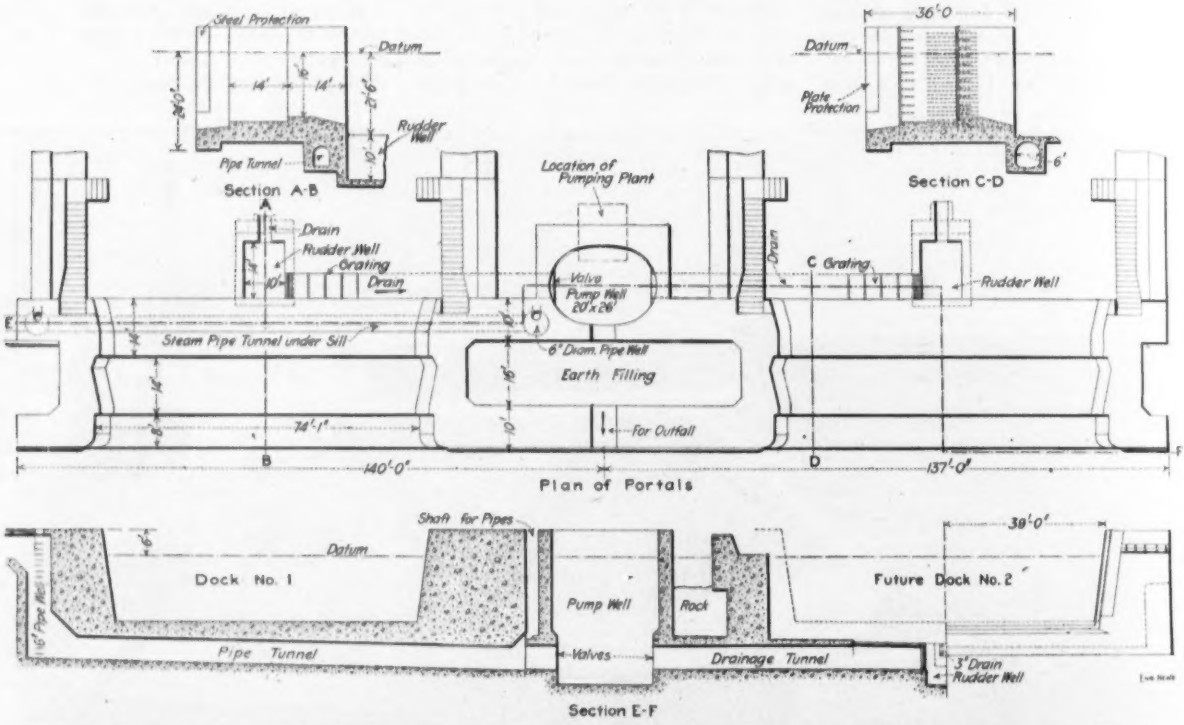


Fig. 1. Plan of Portal for the Two Dry Docks of the Great Lakes Engineering Works, at Ashtabula, Ohio

A. V. Powell, Chicago, Consulting Engineer. Inland Waterways Co., Ashtabula, Ohio, Contractor.

*Engineering News, Feb. 7, 1907.

one 10-in.). A trough or flume was made of 2-in. planks, well calked, to carry the discharge of the pumps over the platform to a ditch leading to a small creek north of the site of the work. This flume cleared the platform high enough to allow a man to walk underneath it. Steam was supplied from a battery of four 50 hp. boilers at the power house, located as shown in Fig. 4.

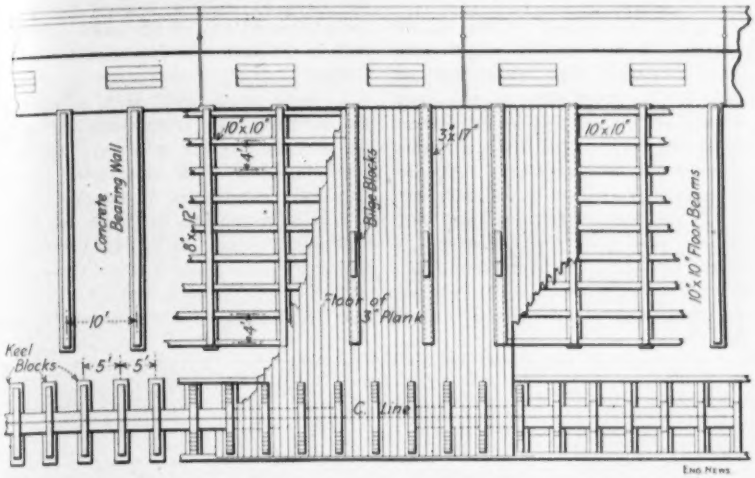


FIG. 2. HALF CROSS-SECTION OF DRY DOCK AT ASHTABULA, OHIO

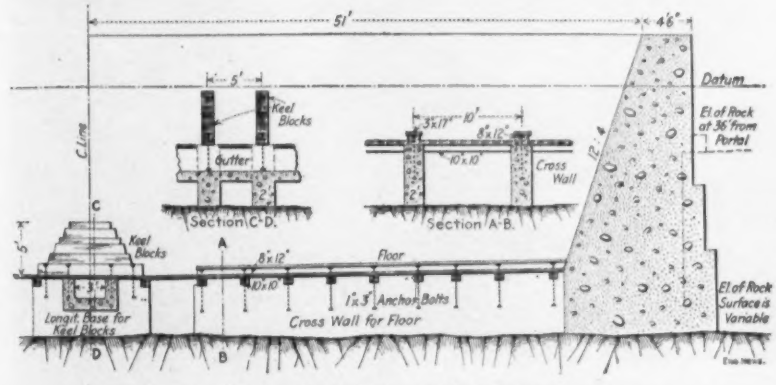


FIG. 3. PART PLAN OF DRY DOCK

Pumping was carried on slowly so as to give the banks a chance to drain and harden as the sustaining pressure of the water was removed, in order to lessen the possibility of slides of earth. When the water level was lowered 10 ft., the pier was sway-braced and a second platform was built between the piles (10 ft. below the upper platform) in order to decrease the lift of the pumps. On this an 8-in. direct-connected centrifugal pump was installed. The distance from the bottom of the slip to the discharge trough was about 28 ft.

As soon as the water was all pumped out, excepting enough to preserve the suction of the pumps, men with wading suits were sent into the pit to hollow out a sump in the rock at the base of the pump pit; this was made sufficiently large to install two 8-in. vertically connected centrifugal pumps. These pumps were coupled to vertical shafting attached to timber leaders and were driven by two 40 hp., balanced valve, horizontal, center-crank engines which were installed on the upper pump platform and were supplied with steam by the boiler battery at the power house. These engines were built for us by the Erie Engine Works. The object of the vertical pumps and sump was to thoroughly drain the pit and provide a dry pit for the concrete work. It was found that the seepage into the pit had been overestimated and that one pump would take care of the incoming water nicely. After installing the vertical pump, the horizontal pumps were removed. This work of pumping was begun on June 6, and was completed June 14, 1911, during which period approximately 17,000,000 gal. of water were removed.

BUILDING THE DRY DOCK

The concrete plant consisted of two main mixing plants, each having a 1-yd. mixer. Overhead storage bins for sand and crushed stone or gravel were fed by a 1-yd. clam-shell bucket which picked up these materials from the storage piles. The bucket was operated in each plant by a guy derrick. Two auxiliary mixing plants consisted each of a ½-yd. mixer to which the sand, gravel or crushed stone was transported in wheelbarrows. One main plant was placed centrally with the north wall, and the other centrally with the south wall of the dock. One auxiliary plant was placed on the south portal wall and the other was placed at the "V" or forward end of the dock. Each main plant was calculated to place 5,000 cu.yd. of concrete and each auxiliary plant 2500 cu.yd. The arrangement of the plant is shown in Fig. 4.

Before pumping out the slip, the sand and crushed stone for the main plants were delivered by vessels, and unloaded and stocked with the clam shell derricks which afterward fed the main mixing plants. The materials for the concrete mixed by the auxiliary plants were delivered by rail. Two cement houses were built in convenient locations, each having a storage capacity of seven carloads of cement. Before pumping out the slip, a pile pier was driven with a floating pile driver for each main plant, and extending far enough out from the top of bank

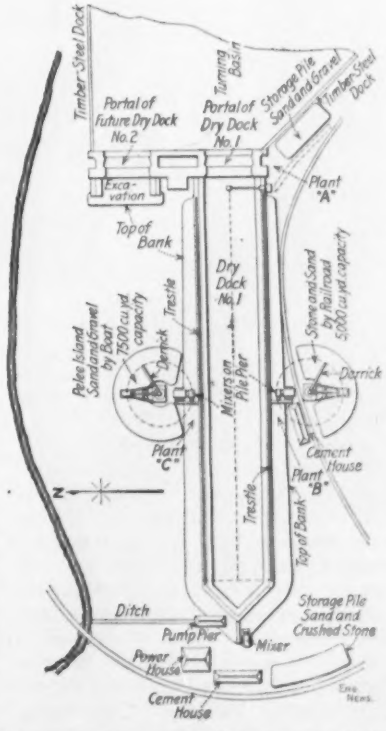


FIG. 4. PLAN OF CONSTRUCTION PLANT AT THE ASHTABULA DRY DOCK

so that the mixer placed thereon could dump into a car running on a trestle behind the wall. This car could in turn discharge directly into the wall forms. As the water level fell while pumping out the slip, sway braces were added to the piles from time to time The cars were Smith 36-cu.ft. side-gate cars, one running each way from each main plant on a trestle extending for the full length of each wall. By this method an empty car was ready to be filled at the mixer as soon as a loaded one left the mixer. The concrete was transported from the auxiliary plants to the forms in concrete buggies of 6 cu.ft. capacity. The cement was furnished by the Lehigh Portland Cement Co., and the crushed stone by the Kelley Island Lime & Transport Co. The gravel was obtained from Lake Erie near Pelee Island.

After the pumping had been completed, the pit presented a formidable appearance, there being from 5 to 7 ft. of liquid mud overlying the surface of the rock, which could not be picked up during the dredging operation, and which was too soft for men to work in. Further, the sustaining pressure of the water having been removed, the banks of the slip or excavation began to crack back for considerable distances in places and several slides appeared imminent. These slides were serious from a contractor's point of view for the reason that the unit price bid included (without extra compensation) the cost of cleaning off the rock preparatory to placing the concrete. The amount of rock dredged from the slip was small and the banks of earth were from 25 to 30 ft. high.

The work now rested on the hazard of a die. A wet season might have caused a heavy loss financially on account of the probability of numerous slides of earth which (as stated above) were to be removed by the contractor without extra compensation. On the other hand, a dry season would spell success, the sun baking the banks and hardening the mud in the bottom so that it could be handled. The contractors were blessed with an extremely dry season. Preparations were made at once to thoroughly drain the mud in the bottom of the pit and in a week's time the hot sun had so hardened this material that it could be shoveled by hand.

The foundation sites for the side walls were cleaned off, the mud being thrown by hand toward the longitudinal axis of the pit: The forms were erected in alternate sections 36 ft. long and the concreting was pushed as expeditiously as possible. The walls were commenced on June 24 and were finished on Aug. 1, 1911, during which period 13,000 cu.yd. of concrete were placed. Fig. 5 shows some of the sections of the wall completed and under construction.

The walls having been completed, portable shear legs were erected at intervals along the top of the side walls and self-dumping buckets were filled by hand with the mud overlying the rock in the dock. These buckets were hoisted up and over the walls by hoisting engines and their loads dumped behind the walls. All the mud in the dock was thus used for backfilling.

As soon as the walls were completed, the concrete plant was dismantled, with the exception of one mixer used to concrete the floor walls and center drain. This work was carried on simultaneously with that of placing the white oak floor beams, floor deck, keel, bilge and scow blocks, etc., which work was commenced Aug. 1, and completed Sept. 24, 1911. It was held up 30 days on account of the failure of the timber dealers to furnish the white oak on time. This order for the white oak was placed on Jan. 31, but was not completely filled until Sept. 20, 1911.

There were placed for the center drain, floor and blocks, 2000 cu.yd. of concrete, 354,000 ft. B. M. of white oak timber, and 33,000 lb. of steel bolts and spike. The total construction quantities for the dock furnished and placed by the contractors were 20,800 cu.yd. of concrete, 355,000 ft. B. M. of white oak timber, and 35,000 lb. of steel bolts and spikes. The total excavation for the dock consisted of 76,400 cu.yd. of earth and 20,230 cu.yd. of rock, which figures include the work of constructing portals for two docks.

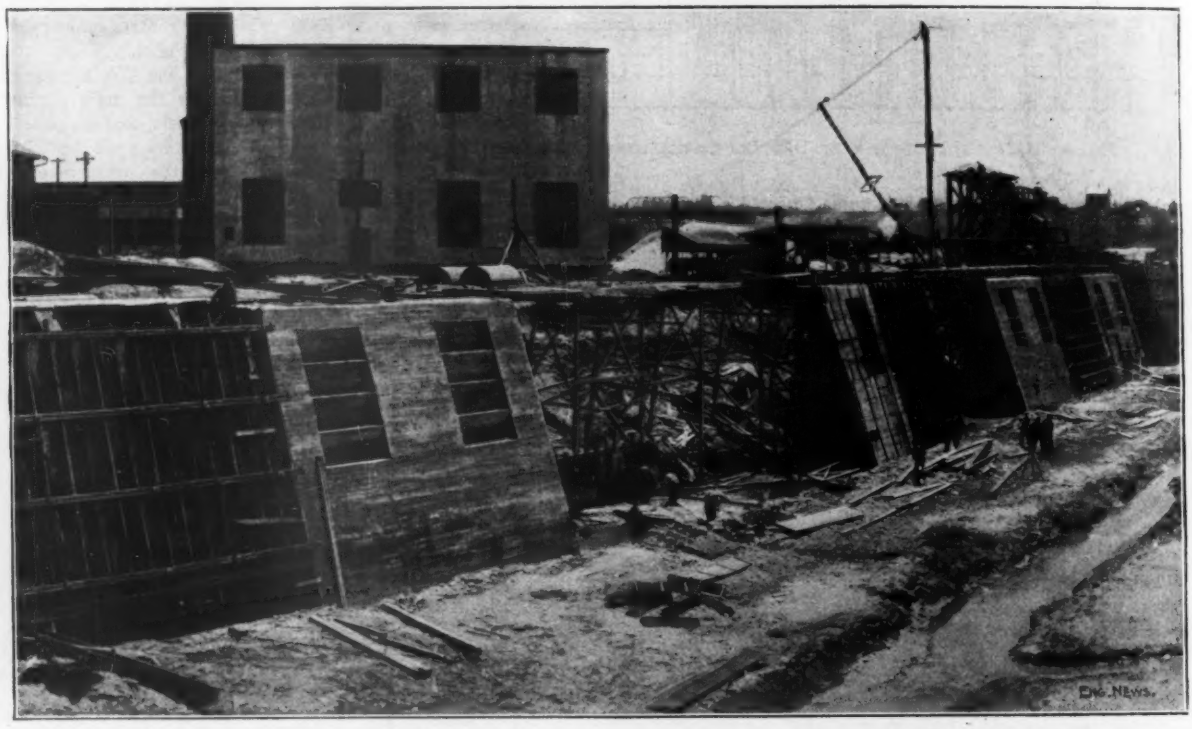


FIG. 5. CONSTRUCTION OF THE CONCRETE WALLS OF THE DRY DOCK

The main body of the back-filling was done as follows: The south side of the dock being accessible to railway tracks, a track was laid along the edge of the south bank. The filling was excavated from a nearby hill by a steam shovel, loaded on flat cars equipped with aprons, hauled to the work by a locomotive, and plowed off into the fill by means of a plow and rapid unloader. The north side of the dock being inaccessible to railway tracks, this fill was made by means of hand shoveling and wheelbarrows, the material being borrowed from the site of the proposed second drydock. The work was commenced Sept. 15, and completed Oct. 26, 1911 during which period 20,000 cu.yd. of back-filling were placed. The front-page view shows the completed dock, with back-filling in progress at the left (north) side.

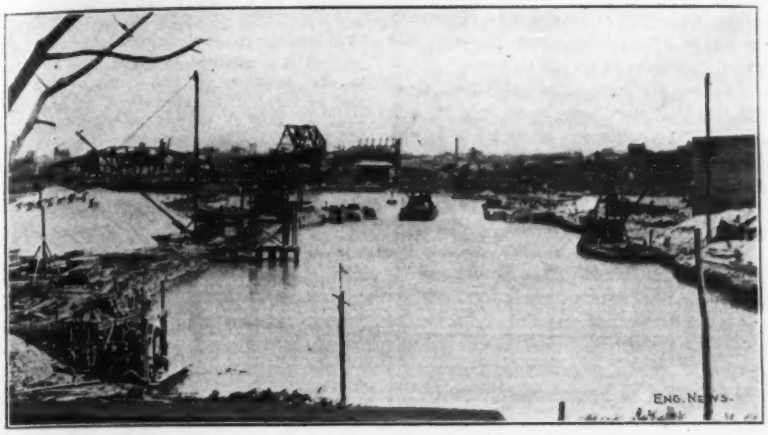


FIG. 6. THE SITE FOR THE DRY DOCK FLOODED TO PERMIT OF DREDGING

(Taken from about the same point as was the front-page view. The clamshell dredge in the center is lying at the portal, which was closed later by the floating steel gate. The large dredge beyond is at work in the turning basin outside the dock.)

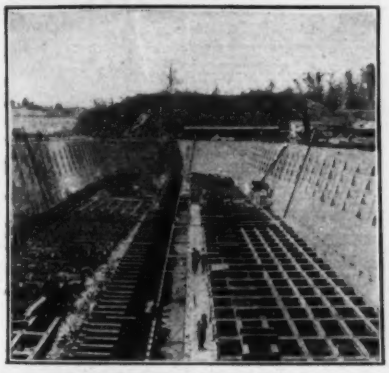


FIG. 7. FLOOR SUBSTRUCTURE OF DOCK, READY FOR THE PLANKING

OTHER WORK

The dry dock above described is a part of the new shipbuilding and repairing plant of the Great Lakes Engineering Works, constructed at Ashtabula during the past year. This plant consists of a machine shop, blacksmith shop, joiner's shop, main shop, power house, store house, building berth 1135 ft. long (equipped with gantry crane), turning basin large enough to wind a 650-ft. boat, dry dock, 1025 ft. of dock frontage other than building berth, store building, office building, etc.

In conjunction with the shipyard construction, the city of Ashtabula improved the Ashtabula River up to the site of the yard from the then existing head of navigation. This work consisted of the excavation of 136,000 cu.yd. of rock, 360,000 cu.yd. of earth, and the construction of 2160 lin. ft. of timber and steel dock. The writer's company was awarded this city contract and completed the same on July 31, 1911. It also secured from the ship building company the contracts for its building berth and the pile and concrete foundations for its buildings and machinery. The executive head for the owners, whose guiding hand was felt from the inception of the work until its finish, was Mr. Antonio C. Pessano, President and General Manager of the Great Lakes Engineering Works.

[The dry dock whose construction is described above is of the same general type as that at Port Arthur, Ont., of which also Mr. A. V. Powell was the consulting engineer, and which was described and illustrated in our issue of Nov. 16, 1911. A feature of the design in each case (as well as in two other docks designed by Mr. Powell) is the absence of the usual continuous benches or altars. The reason for this design, as stated in the article mentioned above, is that the modern lake ship (having practically a flat bottom) rests entirely upon the keel blocks and bilge blocks, so that side shores (to the altars) are not required to hold the vessel upright when the dock is pumped out. Recesses in the walls, however, provide for temporary shoring to keep the vessel in position while the dock is being emptied, as shown in Fig. 4.

At Ashtabula, as at Port Arthur, provision is made for a second dock parallel with and close to the first dock. As the first step in construction, the river wall or bulkhead wall with the portals for two docks was built in a pit excavated for the purpose, the excavation being in dry ground a little distance from the river. The ground between this pit and the river was then removed by dredging, to form a turning basin, and water was admitted through the portal to flood the site of the dock, Fig. 6. The series of operations therefore may be summarized as follows: (1) excavating the portal pit in the dry and constructing in this the river-front wall and portals; (2) flooding the dock site (for dock No. 1) by admitting water through the portal, and dredging the site to approximate shape by a dipper dredge floated through the portal; (3) removing the dredge and floating the steel caisson into place to close the portal; (4) pumping out the dredged pit; (5) building the dock within this pit. By these methods, the construction of a temporary cofferdam was avoided. The steel gate is similar to that employed at the Port Arthur dock and described in our issue of Nov. 16.

The site of the Ashtabula dock is mainly in shale rock, which is very firm and dense, and has practically no seams, so that the excavation was easily kept dry. The surface of the rock is about 3 ft. below the ground surface at the portal but falls to 30 ft. below it at the opposite end. The depth of the floor is about 25 ft. below ground level at the portal and only 20 ft. at the other end. The floor is of novel design. Concrete cross walls

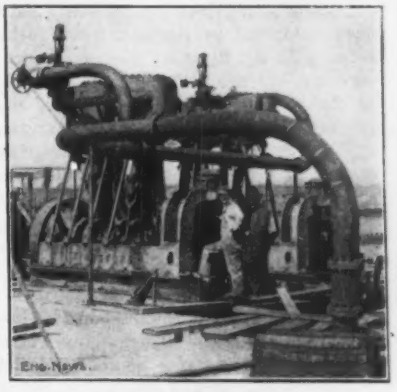


FIG. 8. PUMPING ENGINES FOR THE ASHTABULA DRY DOCK

(The steam pipe at the right comes up a shaft or well from the pipe tunnel leading under the dock from the power house.)

10 ft. apart extend between the side walls and the central longitudinal concrete foundation for the keel-blocks. Upon these walls are laid 8x12-in. timbers, between which are 10x10-in. longitudinal timbers or floor beams spaced 4 ft. apart; the timbers are fastened to the cross walls by anchor bolts. Upon these timbers is laid a floor or deck of 3-in. planks, the planks being spiked in place. Fig. 3 shows the construction and Fig. 7 shows the floor substructure ready for the planking.

Another interesting feature of the dock is the use of a pipe tunnel under the portal of the dock to carry steam pipes from the central power plant to the pumping engines erected at the pump pit between the two docks. The tunnel is shown in Fig. 1. There are two 36-in. centrifugal pumps, each driven by a pair of vertical inverted Kingsford non-condensing engines having two cylinders 20x20ins. This plant (Fig. 8) will serve both the dry docks, and can pump out either dock in two hours. The power house contains the boilers for supplying steam for power and heat throughout the entire plant, and contains also the air compressors and the electric equipment for light and power purposes.—EDITOR.]

Five-Year Tests on Cement Briquettes, Showing Decrease in Tensile Strength

BY C. A. MORSE*

The accompanying diagram shows a set of tensile-strength curves for five-year tests of portland cement which have been conducted by the Atchison, Topeka & Santa Fe Ry. System. Each test represents the average of five briquettes, made of the material, mixture and under the general conditions shown on the diagram. The last three show dotted lines covering the period from two to five years, the reason for this being that there were no tests made in these three cases for either three or four years, but there was a test made for five years.

There is a popular idea that portland-cement mortar and concrete tend to increase in strength indefinitely. These tests were made because we observed that practically all portland cements we tested reached a high point in from 90 to 120 days and then began to decrease in strength. By making a five-year test we hoped to find that the curve had at least become level by that time, but as will be noted, with the exception of two tests, the curve was still dropping at the end of five years. One test showed an increase after two years and another showed the strength at the end of five years the same as at two; the other four, however, showing a decline in strength continuously from two to five years and it will be noted that in no case was the strength at the end of five years as great as it was at the end of 28 days, which would indicate that as far as tensile strength was concerned no value should be given beyond that which is shown on the 28-day test.

These tests have especial value from the fact that they were conducted by one man; all the briquettes were made by the same party, kept under the same conditions and broken by the same man. This is a condition which it is seldom possible to have in the case of a five-year test, and reduces the question of the personal equation to a minimum.

We are conducting a similar set of tests for compression, only it has been but two years since we have started the test. We expect to carry it through for five years, the same as was done in the case of the test for tensile strength.

*Chief Engineer, Atchison, Topeka & Santa Fé Ry. System, Topeka, Kan.

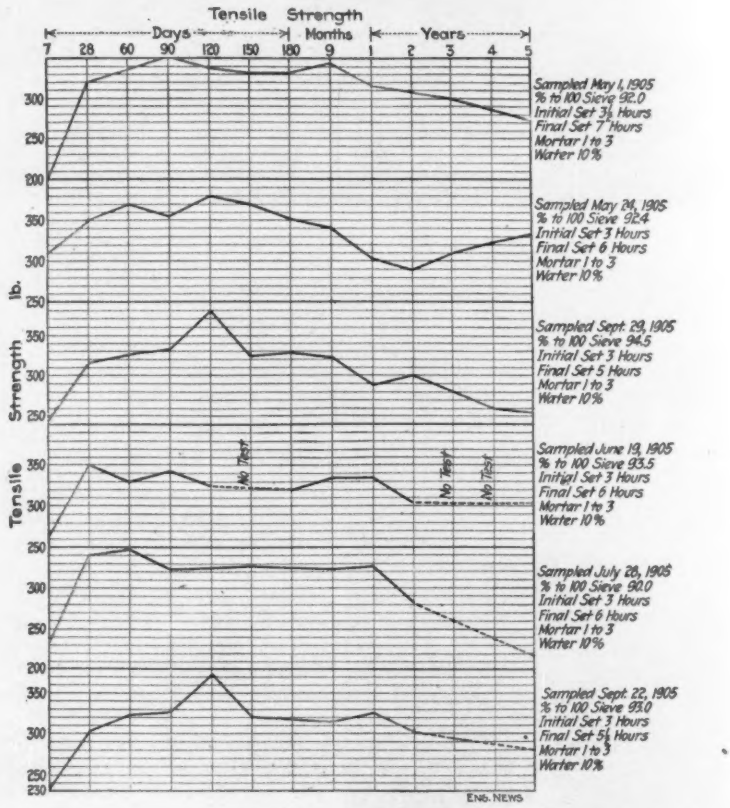


TABLE SHOWING RESULTS OF FIVE-YEAR TENSILE TESTS ON PORTLAND CEMENT BRIQUETTES

(Made by F. B. Murdoch for the Atchison, Topeka & Santa Fé Ry. System.)

The Position of a Projectile in Flight has been determined by the experimental firings at the condemned naval vessels "Katahdin" and "San Marcos," according to the annual report of the Chief of the U. S. Bureau of Ordnance. Two of the most important facts that have been clearly demonstrated, according to this report, are that a projectile in flight is at all times tangent to the trajectory and that the penetrative effects of projectiles at battle ranges on modern armor are in accordance with previously calculated data. These two points have been disputed by some inventors of high explosives, their claim being that the axis of a projectile in flight was parallel to its position at the time of leaving the gun and that, therefore, at high angles of fall it would be impossible to penetrate armor. This theory, it is claimed, has been entirely discredited by the firings at the "Katahdin."

A Motor Truck in Use 17 Years is still in active service at Arbon, Switzerland, according to a statement sent out by the International Motor Co. This truck was manufactured at Arbon, in 1894, by Adolph Saurer and is the original Saurer truck. It was made as an experimental machine for transporting embroidery machinery over the Alps. The original Mack motor truck, which was built in Brooklyn in 1900, was a sight-seeing car constructed for use in Prospect Park, Brooklyn. This has passed through a number of users' hands and has seen service in various large cities in the East. About four years ago it was sold to a firm in Tucson, Ariz., and was converted into a freight-carrying vehicle. It is claimed by the workers, the International Motor Co., that it is still in use in this capacity.

Sewage Purification at Atlanta

By Wm. A. Hansell, Jr.*

Atlanta, Ga., is the first large city in the United States to enter upon the construction of Imhoff tanks for removing the suspended solids from the whole of its sewage and reducing their bulk by septic decomposition.

These tanks, however, form only a part of the complete works, which will include: (1) coarse screens; (2) grit chambers; (3) Imhoff tanks; (4) fine screens at one of three plants and roughing filters at the other two; (5) dosing tanks; and, finally, (6) ventilated percolating or sprinkling filters, provided with nozzles throwing a circular spray under a variable head given by the dosing chamber. Of the three plants to treat the sewage of the whole city, all of which are now under construction, the smaller one is here described as typical of the others, and as furthest advanced towards completion. The capacities of the plants will be: 3,000,000, 5,000,000 and 8,000,000 gal. daily.

*Assistant in Charge of Sewers, Department of Construction, Atlanta, Ga.

In 1888, when Atlanta had a population of about 70,000, Rudolph Hering was called in as consulting engineer with Capt. R. M. Clayton, city engineer, and the first sewerage system for Atlanta was planned and its construction was begun. The work has been continued piecemeal, but in accordance with the original plan. As the limits of the city extended the sewers were built further out, using the same formulas for calculation of sizes, all sewers carrying both the sewage and storm water.

The topography of Atlanta is such that no less than eight distinct sewage outfalls were necessary. No attempt was made to prevent pollution of streams. The rapid growth of the city and the increasing amount of sewage for each outfall soon made the small streams into which the sewage was discharged extremely offensive. Efforts on the part of property holders to have the nuisance abated were unsuccessful for the time being, but the city authorities were aware that a time of reckoning would surely come at a not very distant date. When the efforts of the property holders affected by the pollution of the streams could no longer be disregarded, it was decided to adopt some method of purification. Again Mr. Hering was called into consultation with Captain Clayton and the system upon which we are now at work was planned.

General Scheme

The plan is to construct three large plants to care for the three largest drainage areas and to pump from the smaller areas into the larger ones. The amount of sewage to be treated by the largest, or Peachtree Creek, plant will be about 8,000,000 gal. per 24 hours. The next in size is the Intrenchment Creek plant, which will treat about 5,000,000 gal. daily. The third, or Proctor Creek, plant will treat about 3,000,000 gal. daily.

The method of treatment is to be the same at each plant and the plants will be practically alike, except in size.

As Atlanta was the first large city in the United States (154,839 population by Census of 1910) to adopt the Imhoff tank, it was thought advisable to begin work on the smallest plant first and to get it in operation as soon as possible, so as to have a chance to see if any changes could be advantageously made in the other plants, but the people affected by the nuisance were so insistent on having all three plants completed as soon as possible, that it was decided to let all the work at practically the same time.

The contract for the Proctor Creek plant was let in November, 1910, and the time for completion was 12 months. The Peachtree Creek contract was let in December, 1910, with 18 months for completion, and the Intrenchment Creek contract in March, 1911, with 18 months for completion.

The Proctor Creek Plant

As the Proctor Creek plant was let first and was the smallest plant, it has been much ahead of the other plants in the progress of construction. The following description of the system and construction is primarily of the Proctor Creek plant, but is typical of all the plants:

District and Intercepting Sewers—The main volume of sewage comes from the Beckwith St. sewer, which is a circular brick sewer, 10½ ft. in diameter. This is further increased by the sewage from the West End outfall and will have the pumped sewage from the White St. sewer in addition. The combined normal flow of the three sewers is about 3,000,000 gal. per day.

At the end of each sewer will be a screened inlet to an intercepting sewer of such size as to carry eight times the normal flow of the sewer. The interceptor will take the first part of the storm water, including the street washings and also deposits which may have accumulated in the sewer. By the time the flow in the outlet sewers has increased to eight times its normal amount, the sewers will have been flushed out and the sewage will be only one-eighth its normal strength. When this stage of the storm is reached the interceptor overflows into the old stream and the sewage and storm water are further diluted by the high-water flow of the stream. The overflow sewage is now so diluted that it causes no nuisance in the already muddy stream and when the storm is over the stream will be fed by the springs and small streams running into it below the inlet to the interceptor.

The Proctor Creek interceptor is about two miles long, made of 48-in. lock-joint pipe, with a 2-ft. flat base. At the beginning of the work, the pipe was made at different points along the line of sewer and hauled or rolled to the ditch and into

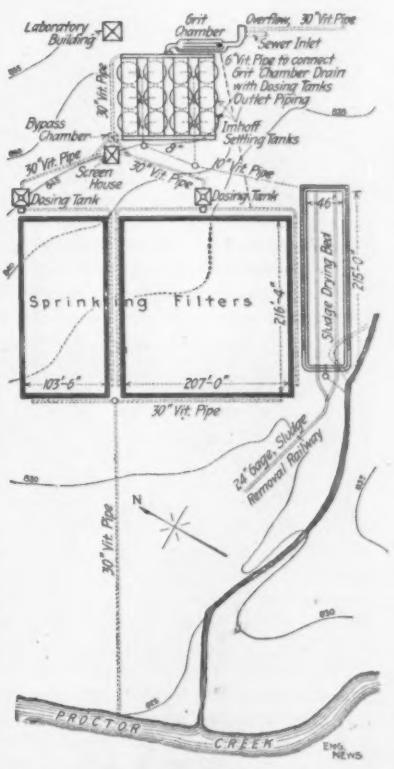


Fig. 1. General Plan of Proctor's Creek Sewage Purification Works, Atlanta, Ga.

(Water levels are as follows: Grit chamber, 855; Imhoff tanks, 854; screen house, 853; dosing tanks, 848; sprinkling filters, 839 at top of stone; sludge bed, 833 at top of sand.)

place, but later the pipe was cast with the molds in the ditch. The latter method was found more economical, as it was very inconvenient moving the approximately 4000-lb. pipe sections among the trees and along the rough land through which the sewer was laid. All the inter-

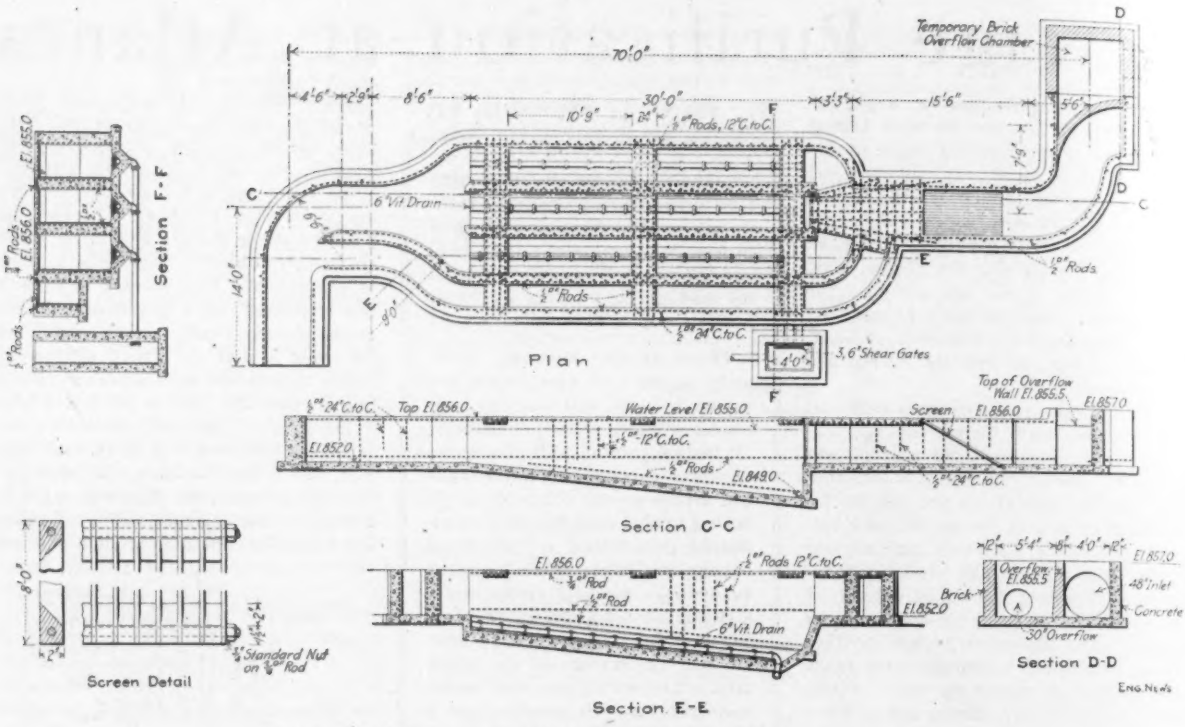


FIG. 2. GRIT CHAMBER, PROCTOR'S CREEK SEWAGE WORKS, ATLANTA, GA.

cepting sewers for the other plants so far constructed are of plain concrete and where the sewer is on a curve it has been found almost impossible to secure as satisfactory work with plain concrete as was secured with the pipe in 4-ft. lengths.

At the discharge end of the interceptor there will be an additional overflow, so as not to surcharge the disposal plant. On account of the sewers in the city being on the combined system, there is always a large volume of street sand and earth carried through the sewers at every storm. So far we have devised no method of catching this sand at the intakes of the interceptors, so it, together with the small stones not caught by the screens at the intake, will have to be taken care of at the plant end.

There is one feature to be solved in this drainage area which will not be encountered in any other plant, and that is the waste from a gas works which makes about 3,000,000 ft. daily of coal and water gas. The present wastes are discharged into the sewer direct from the different processes and frequently an overflow of the tar wells will discharge considerable volume of tar and tar oils. Plans are now under way for caring for these wastes.

GRIT CHAMBER—The general arrangement of the plant is shown by Fig. 1. The interceptor and overflow stop at the sewer inlet and the velocity is impeded sufficiently to settle the sand in the grit chamber, details of which are shown by Fig. 2. After each rain, or as often as

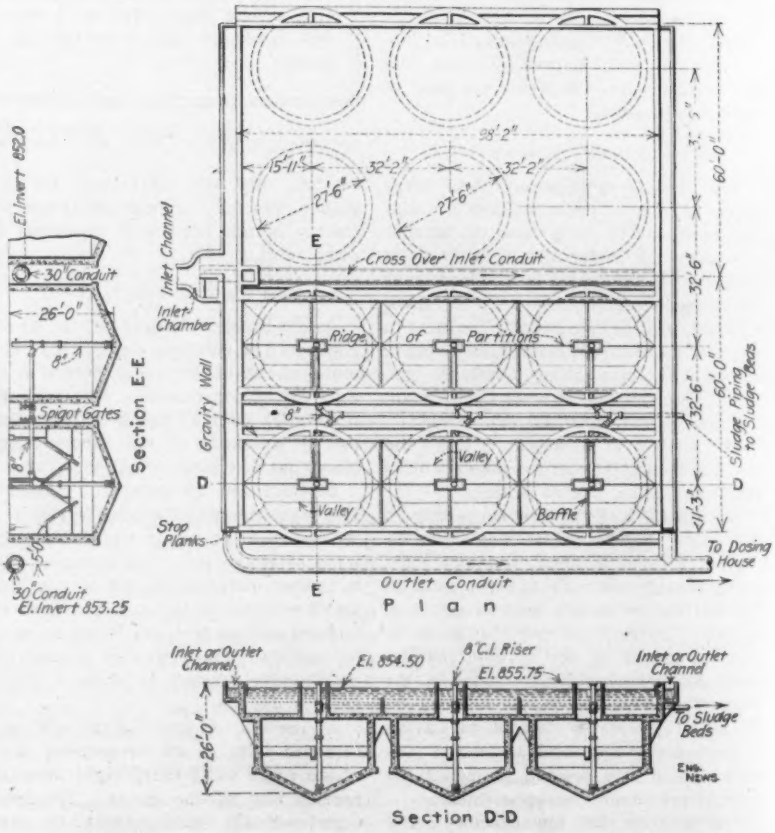


FIG. 3. IMHOFF OR PRELIMINARY SETTLING TANKS, PROCTOR'S CREEK SEWAGE WORKS. ATLANTA, GA.

may be found necessary, the sand will be cleaned out of this chamber. As the area discharging into this plant is hilly and a considerable percentage of the streets unpaved, the volume of sand and small stones to be cared for will be considerable. As shown by Fig. 2, the grit chamber is so arranged that any or all sections can be cut out by stop planks for cleaning or repair.

IMHOFF TANKS—After depositing the sand and stone in the grit chamber the sewage passes to the channel of the Imhoff tank, shown by Fig. 3. There is a channel at each end of the series of tanks, with a bypass arrangement so as to allow the sewage to pass from either side and discharge through the other side. To prevent septic action and smells in that part of the channels not in use, a stop plank and an additional drain will be provided so that the channels can be emptied. The tanks are arranged in series of three. Naturally the greatest amount of sludge is deposited in the first tank, some in the second and only a little in the third. In order to keep the units working together a bypass and cross-over arrangement was put in. By reversing the flow as often as found advisable, the sludge in the chambers can be kept at a uniform depth. For observation, the baffle boards and concrete baffle walls in one series were omitted and tests will be made as to the settling capacity as against that of those with the baffles. The sludge, after being deposited on the inclined slabs, slips down into the sludge-decomposing chamber and stays there until the decomposition is complete.

When ready for removal the sludge is discharged through an 8-in. cast-iron sludge pipe. This pipe is provided with a bell mouth at the bottom and rests on a four-legged cast-iron support. The bottom of the opening is a foot from the bottom of the decomposing chamber and the slope of the bottom is deflected far enough to give free entrance to the bell mouth. A lead water pipe runs down alongside the cast-iron pipe and turns up into the bottom of the bell-mouth so that the decomposed sludge can be agitated when the discharge valve is opened. This lead pipe has holes drilled in it so as to discharge into the mass of the sludge around the bell mouth, also, and thus render the discharging sludge more fluent. In addition to the water pipe at the inlet to the cast-iron pipe, there is another lead pipe under water pressure which runs entirely around the sloping bottom of the decomposing chamber about 5 ft. above the point of the cone. This pipe is drilled with ⅛-in. holes, every 18 in., and the holes open toward the inlet to the sludge discharging pipe. When sludge is being discharged the valve controlling this water pipe is opened and the sludge washed toward the discharge pipe. This keeps the old sludge washed down to pass out, instead of letting the fresh sludge work down from the top. Without these agitation pipes the sludge would settle so compactly as to discharge only from a pocket around the cast-iron pipe, or else the sludge might become so compacted as to clog the cast-iron pipe entirely. As an additional safeguard against clogging, the top of the cast-iron pipe has a connection for a fire hose, and after each discharge the pipe is blown clear of sludge.

After going through the valve the sludge is discharged into an open manhole, so that its condition can be watched by the person operating the valve and the discharge stopped as soon as any undecomposed sludge begins to show.

Figs. 4 to 7 show the Imhoff tanks under construction. The views, together with their titles, are self-explanatory.

SLUDGE DRYING BED—The sludge then passes to the drying bed (see Fig. 1). This is a bed 215x46 ft. in plan, of graded broken stone, with a top layer of sand,

FIG. 4. CIRCULAR FORMS READY FOR PLACING CONCRETE BOTTOM OF TANK

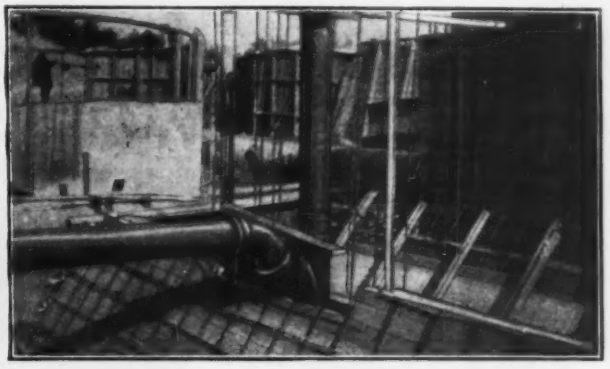


FIG. 5. REINFORCEMENT FOR SLABS SEPARATING SEWAGE CHANNEL AND DECOMPOSING CHAMBER; ALSO SHOWING SLUDGE DISCHARGE PIPE

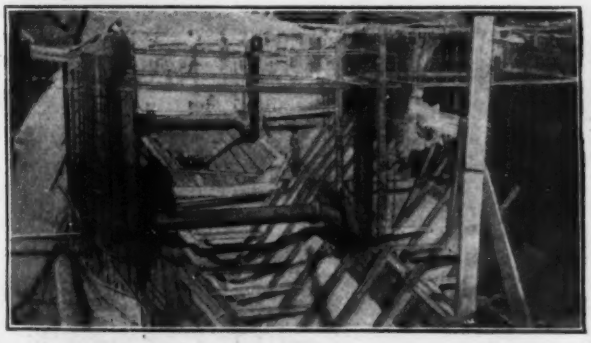


FIG. 6. FORMS IN PLACE FOR SEPARATING SLABS

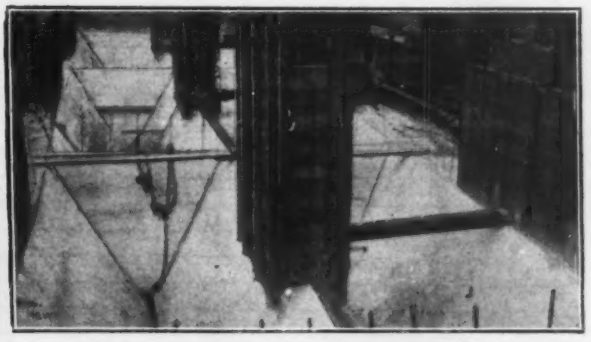


FIG. 7. SEPARATING SLABS COMPLETED

FIGS. 4 TO 7. IMHOFF TANKS UNDER CONSTRUCTION FOR PROCTOR'S CREEK SEWAGE PURIFICATION PLANT, ATLANTA, GA.

and underdrained with 3-in. vitrified pipe. The sludge is discharged onto a concrete slab to prevent washing a hole through the stone and the entire drying area is divided into pens by movable partitions, so that the amount of sludge can be confined in small enough space for each discharge to give a depth of about 10 in. After the water has drained out sufficiently for the sludge to be handled by a shovel, it is loaded into small cars operated on a track provided for that purpose and dumped onto the land around the plant to enrich it, or sold to farmers for manure. It is intended to use all this sludge at the plant for some time, as the grounds will be parked and flowers planted with the idea of making the whole place attractive to visitors and those who live near-by. The water drained out of the sludge bed will be discharged direct into a stream.

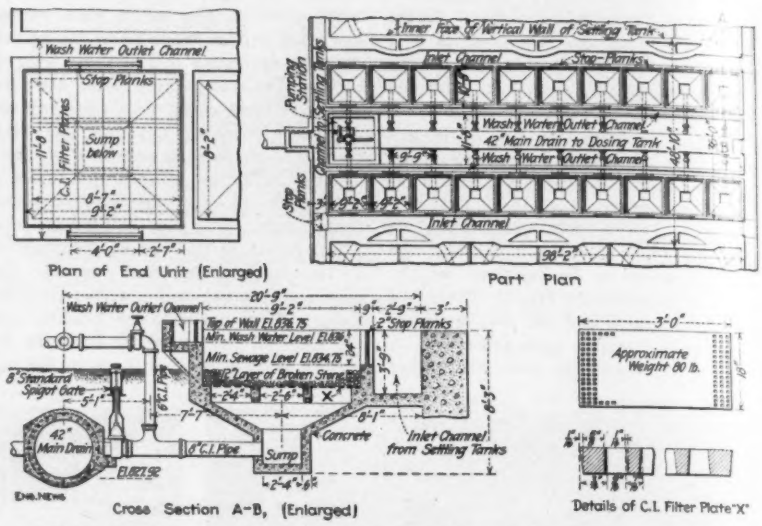


FIG. 8. ROUGHING FILTERS FOR INTRENCHMENT CREEK SEWAGE WORKS, ATLANTA, GA.

SCREEN AT PROCTOR CREEK PLANT—The sewage in the Imhoff tank, after dropping the particles in suspension, passes over the discharge weir into the channel and through a bypass manhole to the screen. The bypass manhole is arranged so that the sewage can go around the screen house in case the wire screen is not in operation. The screen is of 36 mesh and is protected by a 4-mesh screen on the outside, and runs by electric power. Its purpose is to stop any particles which did not settle out in the Imhoff tanks, but which might clog the orifice of the sprinkling nozzles. The particles screened out are discharged into a pit from which they are shoveled out when a sufficient quantity has accumulated.

ROUGHING FILTERS AT OTHER PLANTS—At the Peachtree Creek and Intrenchment Creek plants this screen will be replaced with roughing filters. The roughing filters (Fig. 8 shows those for the

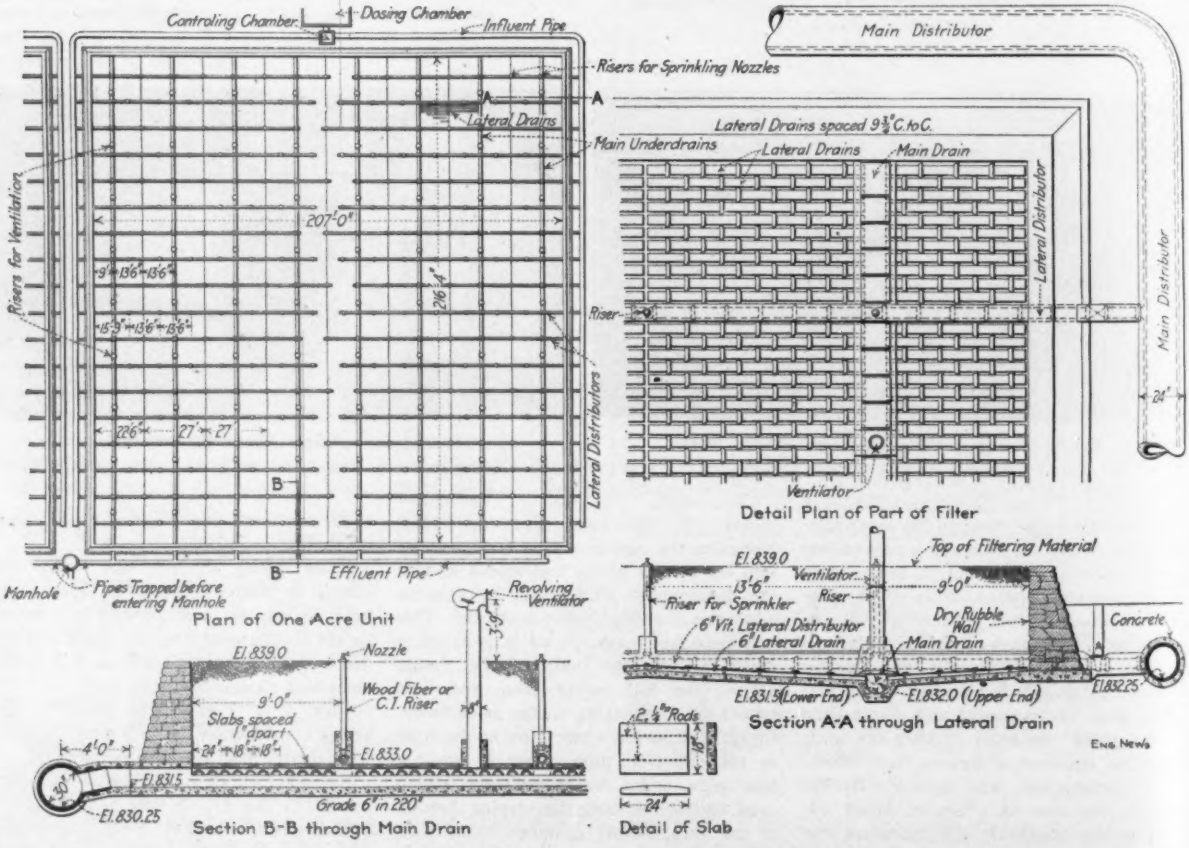


FIG. 9. PERCOLATING OR SPRINKLING FILTERS, PROCTOR'S CREEK SEWAGE WORKS, ATLANTA, GA.

Intrenchment Creek plant) have the advantage of not continuously requiring power for their operation, needing it only when operating the pumps for cleaning, whereas the screen needs power for its operation and needs water under pressure all the time. Alternate bids were required on screens and roughing filters for Peachtree Creek and Intrenchment Creek plants and the prices were the same.

DOSING TANKS—After being screened, the sewage passes to the dosing tank, stop planks being provided at the screen house so that the flow to the half-acre and to the acre sprinkling filter units can be properly regulated. Each dosing tank is provided with a 24-in. siphon, to measure the amount of sewage sprinkled onto the filter units, the normal head being 9 ft. at the starting and 2½ ft. at the stopping point. These siphons are so arranged that the head can be varied 6 in. up or down at both starting and stopping points and are provided with counters so that the amount of sewage passing through them can be seen at any time.

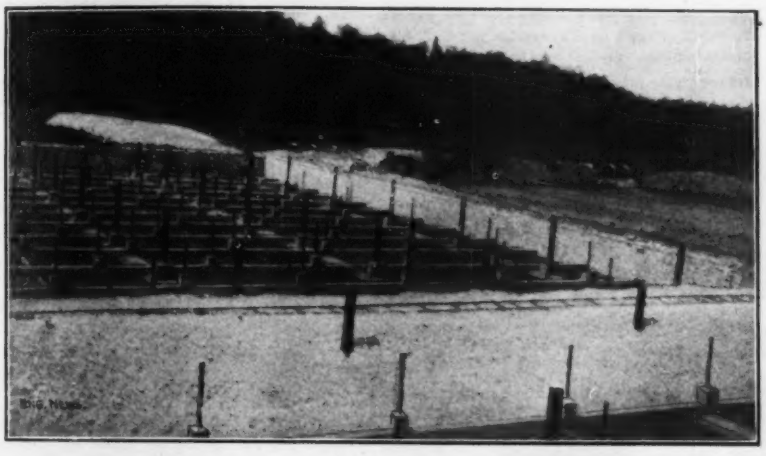


FIG. 10. CONSTRUCTING PROCTOR'S CREEK PERCOLATING SEWAGE FILTERS, ATLANTA, GA.
(Stone in place in foreground.)

SPRINKLING OR PERCOLATING FILTERS—From the dosing tanks the sewage goes to the sprinkling filters (Figs. 9 and 10). Two units are provided, an acre unit and a half-acre unit. The half-acre is put in with the idea of increasing it to an acre when the amount of sewage increases to such an extent as to make the increase advisable. The sewage is fed to the distributing pipe by a 24-in. vitrified pipe, encased in concrete, which goes around the end of the filters. The distributors are of 6-in. vitrified pipe, laid in 12-in. concrete walls, with tees provided for the nozzle risers. These risers are of cast iron, with a bell on top. A fitting is leaded into each bell and nozzle screwed into each fitting. The nozzles will be 13½ ft. c. to c. in triangle arrangement and will throw circular sprays. The variation of head at the dosing tank (already mentioned) will vary the spray proportionately.

The bottoms of the filter beds are a series of ridges and valleys, with a draining channel at each valley. The bottom is of concrete, overlaid with 6-in. half pipe. The half pipe are bedded in ½ in. of concrete mortar. These ridges are level and the slope toward the channels is uniform, the channels being laid with a 6-in. fall in the invert. The channel is 3 in. deep at the upper end and 9 in. deep at the lower end. The channels are covered with slabs, placed so as to leave a space of 1 in. between them. At intervals of about 23 ft. along the channels are 8-in. cast-iron pipe for ventilators. These pipes are fitted with cast-iron dampers so that the ventilators can be cut out if it is desired. To the top of these pipes is attached a copper cowl with a vane so arranged that the cowl always faces the wind. This causes the air to go down into the channel, from which it is distributed to the half pipe and rises through the stone. By this means the bacteria which are near the bottom of the filter get an independent supply of oxygen and the capacity of the filters will be considerably increased. The channels discharge into a pipe with a trapped manhole so that no air can be blown down the channel and out of the pipe. As there are two independent units, it will be possible and interesting to test them with the ventilators of one working and the other closed.

At the Peachtree Creek and Intrenchment Creek plants the sewage from the dosing tanks enters a 30-in. cast-iron pipe and is distributed through 6-in. cast-iron pipes near the surface of the stone. These distributing pipes are supported on cast-iron pedestals. The broken stone for all the sprinkling filters is about 6 ft. deep, between 1½ and 2½ in. in size, and is watched very carefully for dust and screenings.

The effluent from the filters is discharged from the manhole through a pipe into the creek.

A laboratory building has been provided and a chemist and bacteriologist will be secured and this plant carefully tested under the varying conditions existing.

A city-water main will be extended to this plant for water supply and one of the local electric companies will furnish current for the motors and lights.

In this plant, Atlanta has what is considered the very latest and best thing to be built for sewage disposal where nonputrescibility, only, is sought. We recognize the fact that to a great extent the future of the Imhoff tank for several years to come will be judged by its performances here and everything possible will be done to give a fair and square test under normal working conditions. As is the case with every new thing which is considered good, a great many people are adopting the Imhoff tank and after the construction are turning it loose to run itself or quit, just as local conditions work out. Most engineers have not had the advantage of a trip to Europe to study the operation of an Imhoff tank and the Atlanta plant will be the first one in the United States to start operation on a scale suitable for cities of considerable size.

Railway Tie Statistics—In 1910, the steam and electric railways in the United States purchased 148,231,000 crossties, which is 20% more than in 1909 and 32% more than in 1908. Only 15% of this number was used for new track. Nearly one-half the total were oak ties, with Southern pine ranking next; the two together constituted nearly 64% of the total number. Of the oak ties a considerable number, about 2,000,000, were imported from Japan. Of all crossties used, by far the greater number were hewed from the tree, a practice which involves great waste of the wood, yet the proportion so produced was lower in 1910 than in any previous year. The proportion of hewed ties in 1910 was 74%. The average price per tie paid in 1910 was 51c., which is the same as that in 1907, but greater than the figures for 1908 and 1909, which were 50c. and 49c. respectively. About 94% of the total number were used by steam railways.

The number of treated ties reported in 1910 was over 30,000,000, or 21% of the total. This was a gain of 39% over the number treated in 1909, and 28% over the number treated in 1908. About one-third of the total number of treated ties were treated before purchase. The rapid increase in the number of ties treated, however, is due mainly to the increase in the number of plants established by the railway companies themselves. Owing to the fact that electric railways lack such facilities, their reports show a more rapid relative increase in the number of ties which are purchased already treated.

Geology of Dam Trenches*

By Herbert Lapworth†

The paper here reprinted in part was read before the recent failure of the dam at Austin, Penn., and was afterwards sent from England to this journal for publication because of its current American interest in view of that failure. The author states, in a letter to the editor, that the paper is the first attempt, so far as he knows, to deal with the subject from the viewpoint of the practical geologist.

The author deals with the preliminary investigation of dam sites, the sinking of dam trenches, and various conditions affecting the stability of dams. A table giving facts relating to typical British dams is included.

*Condensation of a paper read before the Association of Water Engineers (Great Britain), in 1911. The original was accompanied by folding plates, of which one is reproduced here.

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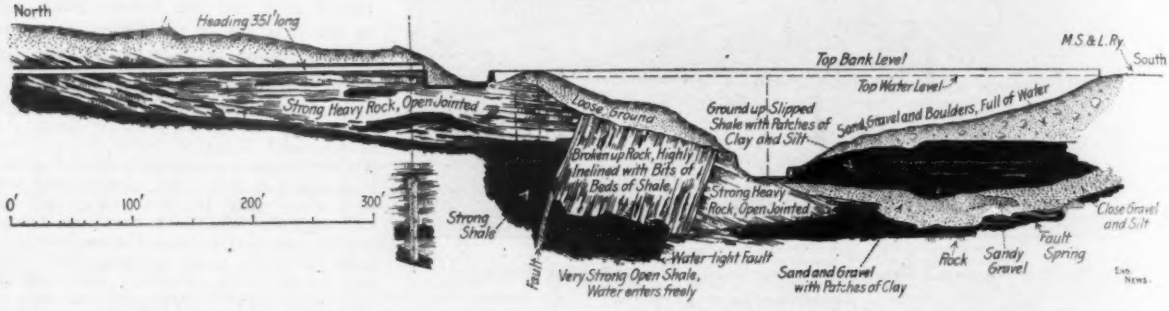
The selection of an efficient economical site for a dam and the question of deciding when water-tight strata have been reached in the trench excavations form two of the most difficult problems with which the water engineer has to contend. The history of reservoir construction seems to show that experience alone does not always guard against failure, and probably also many instances of success must be attributed very largely to good fortune. A complete list of the reservoir failures in America would form a lengthy though exceedingly interesting document. In this country also our own reservoirs might be said to be capable of classification from the aspect of economy. Universally, however, as the result of experience in the early days of dam construction, there has been a movement in the direction of greater care, both in selecting reservoir sites and in trench work generally; but the difficulties of this class of work have not yet proved surmountable.

In reservoirs, as in other engineering works, each case has its own peculiarities; and for this reason it would be impossible to lay down rules, except on the very broadest lines. Hence, the matter of this paper must be largely in the nature of suggestion. There are, however, a few general principles that appear to be common to many dam trenches; and it seemed to the author that the best method of dealing with the subject was to outline these principles, and to illustrate them where possible by actual reservoirs, mentioning the geological phenomena that have added to the cost or have contributed to the failure or success of the work.

The importance of selecting the best site that can be found can hardly be exaggerated, not only from the point of view of a possible failure, whether total or partial, of the work, but from the consideration of cost. Every yard added to the average depth of a trench may mean an expenditure of thousands of pounds, and consequently the careful selection of the best possible site may mean an enormous reduction in the cost of the work. There are probably instances where engineers, by careful thought and ingenious designing, have reduced the expenditure above ground by a substantial sum, and yet have spent ten times the same amount in trench work that might have been avoided had the center line been located a quarter of a mile up or down the valley. We have also the well-known instance of the Vyrnwy Dam, referred to later, where a saving of more than a quarter of a million pounds was effected by altering the site of the dam a matter of only one-eighth of a mile.



GEOLOGICAL SECTION AT SITE OF WOODHEAD RESERVOIR, LANGENDALE VALLEY, MANCHESTER, ENGLAND

PRELIMINARY INVESTIGATIONS AT DAM SITE.

STRATIGRAPHY—The site of the reservoir having been determined and the approximate position of the dam fixed, a contoured geological map of the dam site and the area for some distance above and below should be prepared. A mere inspection of the surface indications and a note of the geological beds or strata alone are not sufficient. The various beds should be plotted on a fairly large scale, not less than 1/2500, so that the map shows the order and levels of the strata. The knowledge of the stratigraphy of a dam site is essential in determining the best position for the dam, for it enables us to determine the underground arrangements of the various kinds of rocks, and to ascertain whether there are any serious faults or disturbances in the area in question. It also helps us very often to comprehend the detailed arrangement of the beds in the trial shafts referred to later. Last, but not least, it tells us whether the area has been subjected to earth movements and the like, factors of almost as much importance as the nature of the rocks on the site. Many of the numerous dam failures on record might have been avoided, had a thorough knowledge of the stratigraphy of the site been obtained before commencing the work.

TRIAL SHAFTS AND BORINGS—No geologist would say that it is possible to prepare a detailed geological map of every dam site without considerable help from trial shafts or borings; in fact, the detail required for this kind of work renders the sinking of numerous shafts almost imperative. In many cases the ground may be covered with drift or scree, or the strata may be jumbled by surface-creep and the like. It becomes necessary, therefore, to seek for further information by means of trial shafts. Of equal importance is the information so obtained as to the jointing, faulting, and folding of the underlying beds when there are few rock exposures at the surface, the thickness of drift or superficial deposits, and the depth at which water-tight strata may be expected. The functions of these explorations should be not only to enable us to examine the rocks in various places in the area, but to interpret the stratigraphy of the site, and by

these means to generalise on the condition of the site as a whole. They should be carried out in such a way as to demonstrate by means of the geological map the true geological structure.

In the author's opinion no expense should be spared in these initial explorations: an expenditure of several thousands of pounds is trivial in proportion to the saving that may be effected by such means. Every piece of information that can be secured before construction ought to be secured almost regardless of cost. It is an unjustifiable procedure to use the main trench as the principal means of investigation, and to incur heavy additional expense by adding wing trenches and the like, when possibly they might have been avoided had sufficient information been obtained in the first place. The explorations should not be restricted to the actual center line, but should be continued up and down the valley for some distance, so as to get the true geological structure and nature of the rocks over a considerable area. Especially also is it desirable to explore the hillsides thoroughly by deep shafts or by headings in order to make certain that water-tight ends may be secured.

Some engineers prefer bore-holes, but these are not nearly so satisfactory as trial shafts. They give practically no information as to the condition of the rocks themselves, unless a diamond drill is used; and here again only a small core is brought up. With shafts, on the other hand, a large surface of rock is exposed in the sides, which can be studied in detail. The shafts should not be less than 8 ft. or 10 ft. square, and in superficial deposits should be well timbered from the commencement. They should be sunk to considerable depths, occasionally well below what is considered will be the final depth of the trench, in order to make perfectly certain that the water-tight strata continue downwards.

Sinking Dam Trenches

The ideal dam is one which has the whole length of its foundations in water-tight rock with all percolating ground-water above the level of the foundations. The object of the trench, of course, is to sink below all loose, open, and unstable materials, these being:

(1) Superficial deposits, such as alluvial and glacial beds of sand, gravel and clay.
(2) Surface material broken up by weathering and surface movement.
(3) Surface or subsurface material broken up by faults, folds and joints.
(4) Subsurface material of a porous or water-bearing nature.
(5) Subsurface material not sufficiently firm to take the weight of the overlying dam.

In England, dam foundations are sunk down to, and well into, the solid rock; invariably in the case of masonry dams, and generally in the case of earth embankments. In America, the rock bottom, as a rule, is regarded as ideal rather than essential. Many American masonry dams have been founded on the superficial deposits, with disastrous results; and in their earth embankments often no attempt has been made to penetrate below the first sound layer encountered.

Superficial Deposits

The advantage of exhaustive initial investigations in superficial deposits is well brought out in the case of the Vyrnwy Dam. The late Mr. G. F. Deacon, in his preliminary survey of this valley, deduced from surface indications that the valley was the site of an old glacial lake, whose waters were at one time held up by a rock-barrier or rock-bar; and he placed the center line for the Parliamentary plans at the spot where he inferred the rock-bar lay. Before deciding on the final center line, however, he investigated the area with in the "stony blue-clay," lying about 13 ft. below the surface and extending for almost the whole width of the valley. Trial shafts and borings, however, showed that underneath this clay was an enormous mass of open gravel, highly charged with water, and acting as a channel for ground water flowing under the clay. It became absolutely necessary, therefore, to carry the puddle down to the rock for nearly the whole length of the embankment.

Again, in the Hury and Blackton reservoirs (Stockton and Middlesbrough water-works) patches of gravel underly the boulder clay. It is, in fact, impossible to say in these circumstances when one may come across such materials, and whether they may not act as channels, bearing water from the reservoir under the embankment. The majority of the reservoir failures in America have been due to dam trenches being founded on superficial water-tight material, without ascertaining what lay below. The result has been, that when the reservoirs have been filled, or partially filled, leakage through porous beds under the foundations has undermined the structures, producing, in many cases, complete failure.

On the other hand, many of our British dams in the glacial deposits have been founded for parts of their length in the boulder clay, and have proved perfectly water-tight. The Font Dam of the Tynemouth Water-Works is an example of this construction.

It has been the general practice, where the depth of boulder clay is very great on the side slopes of the valley, to end the trench vertically against the clay. Both the Vyrnwy and the Upper Neuadd (Merthyr) masonry dams were continued in narrow trenches well into the boulder clay or drift, being founded on rock, but with their ends vertically abutting against the glacial material. In spite of these successes, however, the author is inclined to think that it is unwise to leave the solid rock bottom, unless it has been ascertained that no porous beds underlie the clay, or that the clay deposit is everywhere thick and continuous over the whole area of the reservoir site; that is to say, the preliminary investigation must have been sufficiently thorough to justify the step.

SOLID ROCKS.

A.—Weathering and Surface Movement.—Overlying nearly all solid rocks there is soil, subsoil, and loose rock opened out and broken up by weathering and other agencies. These open materials of course, in dam trenches have to be penetrated because they are loose, unstable, and permeable by water. The depth of these open layers depends on many factors in addition to surface weathering, the most important being the natural jointing of the rock itself in the region, and the amount of folding, faulting, and other disturbing agencies at the dam site. The greater these disturbances the greater the depth of the open surface measures.

The principal factors producing broken-up surface materials, in addition to weathering agencies, are surface-creep and land-slips. A land-slip is generally assumed to take place suddenly; surface-creep is a very slow and gradual process. Land-slips are generally visible on the surface, though not always so. Surface-creep rarely, if ever, makes any sign on the surface. There are many areas of alternate shales and sandstones, such as the Yoredales and Coal Measures of the North of England, where it is rare to find that the rocks do not slope from one side to the other towards the valley. Under such conditions surface-creep is very common indeed; and it is, in fact, often difficult to say whether the disturbed ground is best described as surface-creep or land-slip.

The Leeshaw and Leeming Reservoirs (Bradford water-works) are both apparently in slidden ground of post-glacial age. This creep, due to the gradual movement of the beds at the surface down the slope, often causes the strata in the center of the valley to be buckled up and fractured; but this phenomenon is more frequently due to horizontal regional movement on a larger scale, as will be explained later.

In these shale and grit formations it is not always essential that the beds should slope towards the river for the phenomena of surface-creep and slipping to occur. Thus at the site of the Derwent Dam (Derwent Valley water works) the beds are perfectly level on the west side, yet extensive slipping has taken place above the level of top water.

The explanation of land-slips in level-bedded strata is not clearly understood; but the jointing of the material, in conjunction with the denudation of the valley, probably produces an unstable condition similar to that in railway cuttings where slips have taken place.

Land-slips should be avoided in the selection of dam sites, not only because of the extra cost due to penetrating the broken-up material before reaching solid rock beneath; but if there is a shaley rock-series, there is a possibility of the land-slip moving again after the reservoir is filled, owing to lubrication from the water in the reservoir. The Woodhead Dam of the Langendale Reservoirs (Manchester water-works) is an example of a dam penetrating land-slips. The following is a description of the work:*

The site of the (first or abandoned) embankment was at a narrow part of the valley, one side of which consisted of an ancient and extensive land-slip, which has pushed over the river and formed a steepy escapement of rock and shale on the other side. The valley itself . . . . consists of the shales and beds of sandstone . . . . called by geologists the Yoredale Rocks . . . . The puddle trench of the embankment was sunk to a considerable depth. . . . On the northerly or turnpike road side of the valley the puddle was tied into a thick be dof shale and then turned for some distance up the valley until the shale rose to above top water level. On the southerly or railway side the puddle trench was excavated for a considerable distance into the clay of the land-slip, and in the valley itself the trench was sunk to a depth of 17 ft. below the river into what appeared to be sound ground. The character of the ground was supposed to be ascertained by careful boring before the work was commenced. The boring was . . . . very deceptive, and the foundations did not prove to be what was anticipated. Great care was taken to secure the watertightness of the reservoir, but when the reservoir was filled with water, leakage appeared, which was supposed to be the consequence either of water passing along the outside of the pipes or behind the puddle. Attempts were made to cure the leakage by sinking small cylinders to the pipes and pouring down fine ashes. This operation produced some good, and it was evident that the cause of the leakage had been rightly divined and was discovered; but as it still continued, notwithstanding all efforts to arrest it, it was finally decided to construct a new bank altogether. By careful boring, which occupied eight years, a place was at length discovered at which continuous shale existed right across the valley from top water on one side to top water on the other, and at this spot a new embankment has been formed. . . . . The old bank was left in and the hollow between the two filled up.

*"History and Description of the Manchester Water-Works," by J. F. La Trobe Bateman, F. R. S., page 110 (1884).

Fig. 1 shows a geological section of the second embankment; and if the geology is shown correctly in the longitudinal and cross sections, there is little doubt that there are actually two land-slips extending throughout the whole length of the trench. The northern slip, which is very extensive and deep, was apparently not recognized as such; yet this is much the more serious of the two, a mass of rock nearly 70 ft. in depth and of unknown length having slid on the underlying shales, which dip towards the valley. The broken-up nature of this mass is clearly demonstrated by the fact, that it was necessary to carry a heading 351 ft. into the hill, making a total distance in from top water level of over 450 ft. The site is an extremely bad one, and it is difficult to understand why the second trench was sought for so near the original or abandoned trench, which must clearly have shown the nature of the ground. However, the extensive trench appears to have been the only drawback, for the dam proved perfectly water-tight, and has been in use nearly 50 years.

B.—The Effect of Earth Movement on Sub-surface Materials.—It has already been pointed out that the surface sliding of material often produces in shaley rocks a buckling up or folding of the rocks in the center of the valley. But there is a second cause for these folds, which is more serious, and this is a general or regional horizontal move-

GEOLOGICAL AND OTHER DATA RELATING TO TYPICAL BRITISH DAMS

Name of town	Name of dam	Geological system	Geological series	Particulars of foundations	Length of trench	Length of top-water line	Depth of trench Av.	Depth of trench Max.	Depth of superficial deposits Av.	Depth of superficial deposits Max.	Area of trench*	Remarks
					ft.	ft.	ft.	ft.	ft.	ft.	sq.ft.	
(A) Earth Embankments												
Edinburgh	Talla	Silurian	Llandovery-Tarannon	Greywackes and shales, drift covered	1,400	990	45	80	19	32	63	
Liverpool (Rivington Works)	Yarrow (Turner's Embkt.)	Carboniferous	Millstone grit	Shales, drift covered	2,100	2,100	40	145	22	140	40	Glacial gorges
	Yarrow	Carboniferous	Millstone grit	Shales, drift covered	610	508	62	140	*34	74	75	Glacial gorge *Over central 250 ft. only
Manchester (Langendale Works)	Bottoms	Carboniferous	Millstone grit	Shales and sandstones, drift covered	820	900	31	48	14	35	29	Arm puddle-trenches
	Rhodes Wood	Carboniferous	Yoredale	Sandstone, with one thick shale bed	745	610	22	52	...	...	27	
	Torside	Carboniferous	Yoredale	Sandstone	1,080	820	24	36	...	...	32	Arm puddle-trench
	Vale House	Carboniferous	Millstone grit	Massive sandstones and thick shales, folded	450	415	47	83	...	...	51	Arm puddle-trench
	Woodhead	Carboniferous	Yoredale	Sandstones and shales, greatly disturbed and broken-up by landslips	*940	455	70	151	...	...	162	*Length of trench, including heading
Merthyr Tydfil	Lower Neuadd	Old Red sandstone	Brownstones	Alternate sandstones and marls, drift covered	1,040	655	41	70	38	70	65	
Plymouth	Sheepstor		Dartmoor granite	Granite with veins of elvan; rock decomposed for great depth	655	330	57	105	...	...	113	
Rhyl	Llannefydd	Silurian	Wenlock	Slate, drift covered	640	600	72	122	63	129	77	
Sheffield	Langsett	Carboniferous	Millstone grit	Shales throughout, much affected by lateral creep	1,778	1,400	86	160	...	...	110	
Sheffield	Underbank	Carboniferous	Millstone grit	Massive grit bed and thick shales	1,760	1,386	67	120	...	...	85	
Stockton and Middlesbro'	Blackton	Carboniferous	Millstone grit	Shales, drift covered	1,260	942	49	89	33	75	65	
	Hury	Carboniferous	Millstone grit	Shales and sandstone, greatly disturbed by folding and faulting	1,563	1,358	111	150	51	110	128	
Tynemouth	Font	Carboniferous	Limestone	Shales, sandstones and ganister beds, drift covered	*2,724	1,300	38	94	23	40	79	*Including wing-trenches. Arm-trench not included
(B) Masonry Dams												
Birmingham (Elan Supply)	Caban Coch	Silurian	Upper Llandovery	Compact grits and conglomerates	714	800	55	92	...	...	49	
	Craig Gock	Silurian	Tarannon	Compact slates	700	520	31	60	...	...	42	
	Pen-y-gareg	Silurian	Tarannon	Compact slates	600	500	28	55	...	...	34	
Liverpool	Vyrnwy	Ordovician		Compact slates, drift covered	1,325	1,090	43	61	37	60	52	
Manchester	Thirlmere		Borrowdale	Andesites and tuffs	894	810	20	50	...	...	22	
Merthyr Tydfil	Upper Neuadd	Old red sandstone	Brownstones	Alternate sandstones and marls, drift covered	1,610	1,360	36	76	33	76	43	
Plymouth	Burrator		Dartmoor granite	Granite with veins of elvan	420	340	30	69	...	...	38	

N.B.—The dimensions in many cases were taken from small-scale diagrams. The figures in these tables must be regarded as only approximate.
*Per foot of top-water line.

ment of the whole of the rocks. In cases where the folds die out downwards the movement is attributed by some to general lateral creep, by others to a local movement due to the weight of the hills on either side of the valley squeezing out the beds laterally or horizontally, and resulting in an uplift of the strata in the center of the valley similar to the uplifting movement in the floors of mines and tunnels.

In addition to creep, we may have general regional earth movements on a larger scale, and their effects extend to greater depths; but it is difficult on geological trench-sections to distinguish the two movements. The results of both, however, are identical, that is, to produce more open measures; and so generally is this the case, that the cost of a dam trench may be as often proportional to the effect of earth movements as to the nature of the rocks themselves.

C.—Faults and Joints.—The merits and demerits of faults in dam trenches have been the subject of discussion among water engineers. Some go so far as to say that they prefer faults if they can get them in a dam trench, because they serve as water-tight barriers into which the trench can be tied. Opinions on this question seem to depend mainly on the kind of rocks with which one has had experience. The water-tightness of a fault depends entirely upon the material it separates. If the rocks are generally shaley, the fault rock consists for the most part of fine ground-up shale, often of a clayey nature and water-tight. If, on the other hand, the rocks are of hard material, such as sandstone, grit, or igneous rocks not decomposed, then the fault rock will generally consist of fragments of these materials, with openings allowing the passage of water. In deep mines and tunnels it is nearly always at the faults that most of the water is found, as, indeed, common sense would suggest. In any case, however, whether the fault rock is open or water-tight, the presence of faults indicates earth movements, and their result, as stated above, is to open all the rocks to the freer passage of water, especially in the vicinity of the faults themselves. Advantage can be derived from a water-tight fault in open measures only when it is in a suitable position for tying in the puddle trench and running in a direction which enables it to act as a barrier to the percolation of water from the reservoir, a combination of circumstances rarely obtained.

The natural jointing of rocks below the surface independent of weathering influences is, of course, one of the principal reasons why many trenches have required to be sunk to great depths in the solid rocks, especially where the joints have been widened by earth movements subsequent to their original formation. The natural jointing of rocks extends to enormous depths, though the percolation of ground water through them is confined as a rule to the high measures. The tendency of all jointing, obviously, is to decrease downwards, the joints becoming further apart and the width of the openings diminishing; but it is by no means the rule that a trench sunk deep or carried far into the hill sides will eventually reach material in which the joints are so fine or so widely spaced as to prevent the percolation of water. In the Howden Dam of the Derwent Valley Water Works trial-headings driven hundreds of feet into the hill side showed no diminution in the jointing of sandstone beds, in fact, rather the reverse; for at a distance of 500 ft. in from the surface horizontally and 250 ft. vertically below the surface some joints were as large as 9 in. in width and over 6 ft. in height. These remarkable joints below top-water level necessitated the construction of two long wing-trenches, one on each side of the valley, following the top-water line of the reservoir.

Wing and Arm Trenches.—Where there is a difficulty in getting water-tight ends to a trench, or where there are water-bearing beds in the trench which outcrop in the reservoir, it is a common practice to divert the line of the main trench roughly at right angles, and proceed up the valley with "wing trenches" until the water-bearing outcrop is reached, or until a water-tight end is met with. The trench is sometimes turned into the hill at the end at right angles to the direction of the wing. Where it is a question of founding in water-tight beds such as shales, with overlying open rocks such as sandstone, the direction of the wing trenches should be determined of course, by the dip, and they should run in the line of the steepest rise of the bed. In case where the dip is up-stream, the wing trenches should run down-stream, though this is rarely done.

The second method of dealing with water-bearing beds outcropping in the reservoir is to run out an "arm-trench" up-stream at right angles roughly to the main trench. This arm-trench may have its top and bottom in water-tight strata, and thus the water-bearing beds between are cut off from their out crop when the trench is filled; or the bottom may be in water-tight strata and the water-bearing beds partly cut off by the trench, the remainder on the out crop above being concreted or puddled over. A third method (where, by reason of the geological conditions, no advantage appears to be gained by going up or down stream) is to continue the line of the main trench into the hill in a heading until water-tight material is met with, or for such a distance as is considered sufficient to offer resistance to percolation. The width of wing or arm-trenches is generally not less than 5ft. 6in, or 6 ft. for convenience of working.

Leakage from Reservoirs

Where the trench has been carried laterally into the hill to a considerable distance, and some doubt is felt as to the water-tight nature of the ends, some engineers have left vertical shafts at the ends of the completed headings with means of approach for inspection during and after the filling of the reservoir. This has the great advantage of proving whether the ends are sound and of locating the leakage if any occurs.

The question whether leakage from a full reservoir, either under or around the trench, is serious or not, is one on which opinions differ among engineers of different countries. In America and India, for example, puddle trenches are not carried to such great depths as in Britain. Sometimes the puddle core is altogether omitted and leakage is expected, systems of drains being provided for carrying away the percolating water. The general opinion in these countries seems to be, that it is a waste of money to spend large sums in order to stop small leakages of water. So long as the leakage does not affect the stability of the embankment, or wash away the puddle in a clay trench, there is something to be said for this attitude; but the difficulty when dealing with an imperfect piece of trench during construction, always lies in deciding what is likely to be the amount of leakage when the full pressure of the reservoir comes upon the foundations. The catastrophes that occurred in the early days of reservoir construction in this country, though not affecting so much the question of selecting sites, have led British water engineers to aim at perfect water-tightness of the trench work, and the general practice is, if possible, to carry the work laterally and downwards into retentive material. It has not always been possible to secure these ideal conditions, the extra cost involved in obtaining them having sometimes rendered such a course prohibitive, and the result has been considerable leakage, sometimes unforeseen, sometimes expected, or even created by leading the water up from the foundations in vertical pipes. The leakage is allowed to escape into the river below the dam as compensation water, and care is taken to protect the puddle by means of concrete. This practice was adopted in the case of the Yarrow Dam of the Liverpool (Rivington) Water Works, where a strong spring was met with at a depth of about 150 ft. below the surface, and since then, in many other trenches in this country.

Where the area of the leakage channels is small, or where the frictional resistance of the water-passages is suffi-

cient to prevent high velocities, the tendency is for silting to take place, and for the leakage eventually to cease. This has occurred in innumerable instances in America, India, Britain, and elsewhere. An interesting example is mentioned by Mr. G. H. Hill* of a reservoir 80 ft. deep, in Yorkshire, where a leakage of 440,000 gal. a day took place through fine joints in the rocks, but ceased entirely by the end of two years. On the other hand, there is a reservoir in this country, where the leakage through fissures in the rock has increased by five or six times within ten years, probably through the washing out of the fissures. The danger of leakage through fissure rock, where not led in prepared channels, lies in its tendency to undermine the embankment or to attack the puddle. Finally, it must not be forgotten that there are instances of dams, where the leakage through fissures in the rock was so excessive, that the reservoirs were not capable of being filled.

Grouting, or forcing cement grout under pressure, is sometimes recommended as a means of stopping leakage from a reservoir through jointed or fissured rocks. While this may reduce the amount of leakage, it is, in the author's opinion, scarcely ever likely to be successful in stopping the flow, except by an extraordinary chance. Reservoirs that have leaked through open joints have, however, been successfully treated by adding wing or arm trenches, or by subsequent covering of the water-bearing outcrop with a layer of either puddle or concrete. This last method has been successful in stream courses in the Edinburgh district in preventing water percolating into adjacent mines.

TABLE OF TYPICAL BRITISH DAMS

The accompanying table gives geological particulars of a few typical British dams. In addition to the average and maximum depths, a column is given showing the "area of trench per foot of top-water line." The figures in this column give in a rough way the factor of efficiency of the trench which the average depth would not do, unless in all cases the lengths of trench and the top-water line were identical. It is clear that where the trench has been carried far into the hill sides, the average depth gives no idea of the efficiency of the trench. The particulars in this table are perhaps of no direct use, but they are of interest in comparing one dam with another in the light of the geological conditions of the site.

A New Engineering Society in England. "The annual general meeting of the Engineering Golfing Society will be held at the Institution of Civil Engineers, Great George St., Westminster, on Wednesday, Feb. 28, at 12 o'clock noon." —"The Engineer," London, Feb. 16.

*Proc. Inst. C. Eng., Vol. 132, p. 208.

Water Measurement and Prevention of Water Waste in New York City*

The rainfall in the Croton watershed from July 1, 1910, to Aug. 1, 1911, was only 38.91 in., whereas the average should have been 53.63 in. This extraordinary decrease of nearly 14¾ in. resulted in an extreme drought, which so depleted our reservoirs as to justify fears of shortage in the supply for the city, with the attendant discomfort and even danger to the community, as well as serious material losses.

The department, therefore, gave preferential attention to the work for the prevention of water waste, and at the same time made preparations to secure an emergency supply from the Ten Mile River, from which some fifty million gallons per day might be obtained, if required.

In pursuance of these plans the pitometric work already under way was more actively pushed forward, and at the same time a large force of inspectors was assigned to the house-to-house inspection. As a preliminary measure, consumers were advised through the press and by printed circular of the critical condition of the water supply, and the need of extreme care to avoid waste. They were also notified of the forthcoming inspection to detect leaky fixtures and informed that they would be expected to repair these fixtures or incur a fine in case that on a second visit the fixtures were found still leaky. This public notice had a beneficial effect, our citizens in almost all cases readily coöperating with the department to avoid needless waste.

The inspecting force consisted of 120 inspectors and was under the immediate direction of the water registrar; the laying out of the districts, pitometer work and computations were under the charge of the chief engineer of water supply. For the purpose of the work, various districts were laid out by the engineering force, selected with regard to the probability of large wastes either in domestic service or mains. Pitometer measurements were then made to determine the consumption in the various districts, after which the inspectors examined all the buildings comprised therein, and gave notices of the leaky fixtures so that they might be repaired. After the house-to-house inspection, as well as the necessary repairs to fixtures, were completed, a second measurement of the consumption was made by pitometer, and the difference between the first and the second determination by pitometer showed the amount saved by the house-to-house inspection. If, owing to any doubt as regards the accuracy of the measurements taken, or for any other reason, it was deemed advisable, a third determination was made.

Fig. 1 shows the layout of the various districts in the Borough of Manhattan. Fig. 2 shows water-front investigations made by the pitometer division to determine leakage from mains into the river, defective valves and hydrants, hatched to indicate completed and uncompleted districts; Fig. 3 gives similar information for Brooklyn.

In addition to waste detection and prevention, and germane to it, measurements were taken to determine the flow in trunk mains and consumption in areas of the distribution system in which pump displacements or other records did not apply. This work included the examination of trunk mains and pressure surveys to locate excessive friction losses in the distribution system and the points needing reinforcement. It also led to the detection and permanent stopping of a large amount of leakage which otherwise would have increased the general shortage of Croton water already referred to. Among others, special mention may be made of a leakage of 4,000,000 gal. per day detected and stopped in the flexible-joint pipes crossing the East River to Blackwells Island and of 1,700,000 gal. per day in lines crossing to Wards Island. In both cases the leaking lines were immediately shut off, pending repairs, and the island pressures were materially increased by supplying them through reserve lines. The permanent stopping of these leaks alone resulted in a saving to date of 2000 million gal.

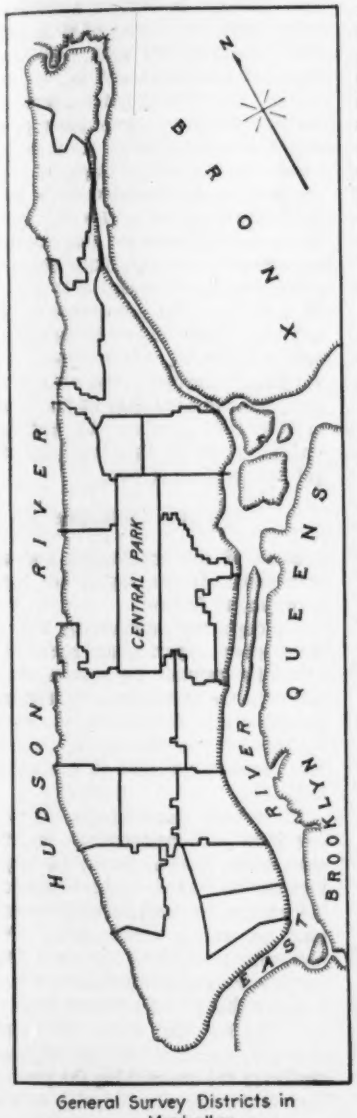
This general work has also led to the discovery of a number of closed valves in the system, among them three 36-in., one 30-in., and two 20-in. trunk-main valves, the opening of which has materially improved pressures in districts supplied. One 20-in. valve was on the main supply of the tower service, and, by opening it, pressures throughout that area were raised 5 lb. and danger of inadequate fire supply eliminated.

Through the determination of flow in trunk mains and their hydraulic gradients, together with determination of the gradient elevation through portions of the distributing system, pressures have been improved by locating points needing connections. Much of the low-pressure trouble of the East Side high-service area was found to be due to excessive friction losses in overtaxed supply mains for a portion of the distance from the 98th St. pumping station, resulting in plans which, by the laying of about 4200 ft. of 36-in. and 1800 ft. of 20-in. mains, will raise pressures east of Central Park by about 15 to 20 ft., with a given head at the station. By a pressure survey of this section small areas of low gradient, due to lack of connections and short extensions of existing mains, were also located and adequate plans prepared to improve the

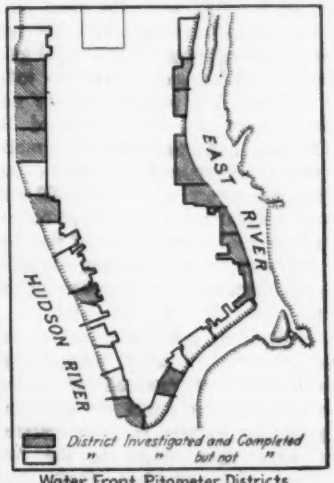
*An official statement from Henry S. Thompson, Commissioner of Water Supply, Gas and Electricity, New York City, prepared by request of the Editor.

same. Points have also been located in the East Side low-service area in which the gradient on the system was found to be 10 ft. below that of the large main running through it, but connected only at widely separated points.

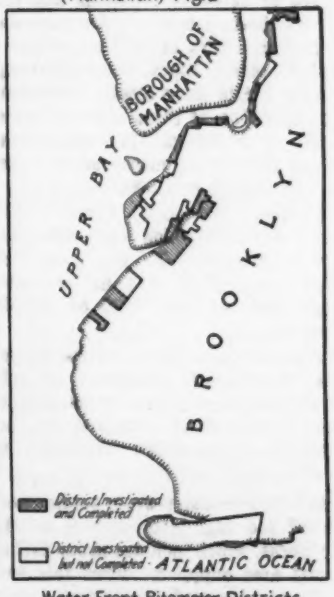
The water-front investigations were generally conducted as follows: A narrow district including five or ten blocks of the water front was isolated from the rest of the system by closing the street valves and selecting one main as a temporary supply. A pitometer was set on this main and a 48-hr. gaging made of the total supply. The metered consumption was obtained by a special reading of the meters in the district at the beginning and end of the test. Supply to shipping, through dock hydrants or any other large unmetered consumption, was accounted for by a record of the boats drawing, size of tanks, etc., kept by men on watch. Other unmetered and domestic consumption—usually a small part—was estimated on a basis of per capita consumption or on a rate per 1000 sq.ft. of floor area, and the total thus accounted for was compared with the total measured supply to the district. If the discrepancy between the total supply and the amount accounted for was negligible, or too small to pay the probable expense of locating, no further investigation was made. If the discrepancy was large, the district was divided into two or three sub-districts and a similar test made of each, or else a night subdivision made in which successive blocks were eliminated from the district by operation of street valves, the consumption and leakage in each being indicated by a simultaneous change in rate recorded by the pitometer. The size of the district, the percentage of water unaccounted for, number and size of consumers, are some of the factors which determine the extent of the investigations in each district.



General Survey Districts in Manhattan
Fig.1



Water Front Pitometer Districts (Manhattan) Fig.2



Water Front Pitometer Districts (Brooklyn)
Fig.3

FIGS. 1 TO 3. WATER-WASTE DISTRICTS FOR HOUSE-TO-HOUSE AND PITOMETER SURVEYS IN NEW YORK CITY IN 1911

The work on water-front waste detection in the Boroughs of Manhattan and Brooklyn has been carried on for about fourteen months and covers 26 miles of water front, of which 17 miles have been completed, resulting in a saving of about 6,700,000 gal. per day, valued at $109,000 on the basis of metered water at $133 per million gallons, and $40 per million gallons for unmetered water.

The saving in the 19 districts inspected and examined by pitometric gagings amounted to 25,251,000 gal. per day, corresponding to about 13% of the consumption. Up to Jan. 1, 1912, the total saving by the stoppage of leaks detected by direct pitometer measurement amounted to 13,028,000 gal. per day. The above daily saving through the period elapsed in each case up to Jan. 1, 1912, would amount to 4093 million gallons.

The accompanying table summarizes the results obtained through the work of waste prevention from June 1, 1911, to Dec. 31, 1911:

AVERAGE DAILY WATER CONSUMPTION IN 1910 AND 1911, MANHATTAN AND THE BRONX

(Consumption in million gallons daily)

Months (1)	1910 Actual (2)	1911 Estimated* (3)	1911 Actual (4)	Decrease in Consumption Actual (5)	Decrease in Consumption Estimated† (6)
June	329	339	286	43	53
July	342	352	287	55	65
Aug.	336	346	275	61	71
Sept.	335	345	277	58	68
Oct.	332	342	278	54	64
Nov.	321	331	270	51	61
Dec.	333	342	283	50	60
	333	343	280	53 m.g.d.	63 m.g.d.

*Assuming increase 3% annually, due to increase in population.
†Assuming consumption of 1911 had continued on 3% increase basis.

(a) Total saving as per column (5)	11,380 m.g.
(b) Total saving as per column (6)	13,520 m.g.
Value of water saved as per item (a) (as unmetered) at $40	$455,200
Value of water saved as per item (a) (metered water) at $133	1,513,540
Value of water saved as per item (b) (as unmetered) at $40	540,800
Value of water saved as per item (b) (metered water) at $133	1,798,160

The total cost of the pitometer work and of the house-to-house inspection from June 1, 1911, to Dec. 31, 1911, was as follows:

Pitometer work		$22,950
House-to-house inspection	$58,158	
Less fines imposed for not repairing leaky fixtures	29,184	28,974
	$28,974	$51,924

Water-Waste Surveys at Milwaukee, Wis

A study of pump slippage and of water consumption and waste is the subject of a report just made by the Bureau of Economy and Efficiency of the City of Milwaukee. The present report is the first of a series of reports dealing with the water department. The water department's studies are being made with the coöperation of J. A. Mesiroff, city engineer, and various members of the water department. This particular report is addressed to H. E. Briggs, commissioner of Palmer and W. R. Brown, both of Chicago, assisted by three others. Prof. John R. Commons, of the University of Wisconsin, Madison, Wis., is director of the Bureau of Economy and Efficiency.

Pump Slippage

Pitometer tests of pump slippage showed a difference of from 1% to 43% and an average of 9½% between the theoretical pump displacement and the amount recorded by the pitometer. After repairs had been made, the slippage shown by the pump which had the highest slippage was only 10%. The average slippages shown by the last test made were 1% for one pump, 2% for two of the use, of which 1224, or 83.3%, were 1% for one pump, 2% for two of the pumps, 3% for two, 4% for one, 10% for another, 14% for still another and 25% for the worst one of the eight.

Water-waste Surveys

Two districts were chosen for a fairly detailed water-waste survey. All feeders but one to each of the districts was cut off and pitometer records were obtained for each of these districts. In the first district studied, two instruments were used at the outset. One of these was supplied by the Pitometer Co., of New York City, and the other was supplied by the Water Works Specialty Co., of Chicago. As many of our readers know, the regular pitometer makes its record in the form of a photograph, indicating velocity head. The newer instrument, to quote from the report, "produces a direct pen record, showing the actual velocity or day rate of gallons flowing at any time over the period of test." The report states that although the two instruments checked agreed closely on the first record taken, it was decided best to use the regular pitometer only on the work "because of the fact that the Water Works Specialty Co.'s instrument is of recent invention and was not furnished in time to allow a careful laboratory test to be made as to its accuracy."

In the first of the two districts studied, there was a total of 1384 service pipes in use, of which 1224, or 88.3% were metered. This district is occupied by stores, wholesale houses, office buildings, tenement houses, railroad yards, etc., and includes 20 unmetered service pipes supplying municipal buildings and other public consumption in the district. In addition, 33 unmetered services were supplying fire-sprinkling systems.

By putting a force of 20 meter readers at work, all meters in the district were read within a single half day on July 12 and again on July 21. The total consumption, as indicated by the pitometer, was at the average rate of 3,618,000 gal., of which 2,335,000 gal. passed the individual meters. The amount used by unmetered consumers was estimated at 107,000 gal., and that used for public pruposes, as determined by estimate and by direct measurement, was 522,000 gal. This left 654,000 gal. unaccounted for, or 18% of the total consumption of the district. The metered consumption was 64% of the total consumption and waste of the district.

An analysis of meter-test records led to the rejection of meter slippage as an explanation of unaccounted water. House-to-house inspection showed that "the plumbing fixtures in most metered places were tight, while in the few assessment-plan premises there was evidence of defective plumbing and that water was being misused." An inspection trip through a 5-ft. sewer showed that 2 out of 20 service pipes, passing through the sewer within three blocks, were leaking badly. One of these was leaking at the rate of 20,000 gal. per day, as determined by a meter measurement. The other was leaking at a 5000-gal. rate.

A pitometer test located a joint leak in a 6-in. main from which water was flowing at the rate of 50,000 gal. a day. At another place there was an estimated leakage from a water main of 100,000 gal. per day.

The water-waste survey of the second district chosen was conducted on substantially the same line as those just described. This district showed an accounted-for consumption or waste of 23% of the total supply.

Less intensive water-waste studies were made of the high-level district of the water-works, which includes about half of the total area supplied. From this survey it was estimated that either underground waste in the distribution system or illegal use of water amounted to 4,276,000 gal. a day. Pitometer tests of nine large mains at river crossings showed them all "to be in good tight condition."

Analytical studies of the waste of water by the city itself indicated that 17% of the water supplied to the city services is wasted or used for unnecessary purposes. It was concluded that large amounts of water could be saved by controlling the supply to horse-watering troughs by means of spring cocks and by utilizing the overflow from ornamental fountains to supply watering troughs which are now, or were at the time of the survey, supplied independently.

It was concluded that "most of the unaccounted-for consumption or loss of 20 to 25% is due to underground leakage, or to the misuse of water in sprinkler systems or unmetered services."

The average daily per capita consumption of water in Milwaukee has ranged from 106 gal. in 1880 to a maximum of 113 in 1887, a minimum of 80 in 1901 and 1903, while in the year 1910 the consumption had amounted to 111 gal. per capita. We infer from the report that the decline in average daily per-capita consumption accompanied a material increase in the percentage of services metered. It appears that while the total number of meters in use has increased from year to year, yet that "during the last three years the daily consumption per capita has increased over 19%, from 93 to 111 gal., the percentage of average daily pumpage metered has decreased over 8% instead of increasing proportionately." Obviously, the per-capita consumption will soon pass its maximum figure of 1887 "unless the underground leakage of water, its misuse and its illegal use are soon stopped."

General Conclusions

Some of the conclusions and recommendations of the report are reprinted herewith, as follows:

Although the engineering and water-distribution departments have tried to efficiently maintain the system, the water waste in the distribution system has increased faster during the last two years, due to underground leakage and illegal use, than at any time in the history of Milwaukee.

It has been repeatedly shown from the operation and maintenance statistics of other water systems that while large savings can be made by inspecting and forcing repairs on unmetered premises, the total net saving accomplished after all necessary inspections are made does not warrant the expenditure and effort. It is believed that if the methods listed below for reducing the waste of water are properly executed by an organization similar to the one making the preliminary survey, the immediate saving to the city will more than take care of the expense involved and at the same time will gradually place the distribution system in an efficient operating condition.

It is impossible to state what the total yearly saving to Milwaukee would be if this underground waste were eliminated, as the data at hand are insufficient for the determination of the amount of reduction which would be made in the various items of yearly expense of operating the Milwaukee water-works, or the accrued value to the system due to the increase in its capacity with respect to the ultimate number of consumers.

Such items as expense of coal, station operation and maintenance and the capacity of intake, pipes and feeder mains are involved. Feeder mains are pipes of 16-in. diameter or more. The increase in capacity of smaller sized mains cannot be rightly credited to such a saving.

The reduction in coal consumption would be in nearly direct proportion to the water saving, which would mean a saving of over $5000 per year in coal alone, if a leakage amounting to 15% of all the water pumped during the year 1910 could be stopped.

This amount alone would cover the yearly expense of a good waste-survey organization to carry on efficient work in locating bad territories and tracing down trouble. An additional fund would have to be available for bearing the increased maintenance expense required for correcting the defects as they were located.

Methods of Reduction and Recommendations

Following are the recommendations and methods to be adopted for reducing water waste throughout the city:

(1) That the Common Council pass an ordinance requiring that all private water consumers, including those being supplied under the assessment plan, for elevator service, and for automatic-sprinkler purposes, be supplied through approved meters only.

(2) That the Common Council pass an ordinance placing the ownership and maintenance of service pipes upon the city or establishing better standards of service-pipe construction and inspection by the city to insure the proper installation of the very best materials at a reasonable expense.

(3) That the Common Council pass an ordinance requiring the metering of all public services, including parks, public buildings, fountains and drinking troughs so as to regulate their useful consumption.

(4) That the Water-Works so distribute hydrant wrenches to individuals and corporations as to assure the city a fair income from such use and protection against their misuse.

The use of hydrant wrenches by contractors, corporations and private concerns means a great deal of expense to the city in increased maintenance and repairs to hydrants, and should be abolished when possible. Some other means should be devised to furnish water for the purposes that are now supplied in this manner, so that the use of hydrant wrenches will be ultimately eliminated except for use by the city water and fire departments.

(5) That all newly-laid mains be tested by means of some such equipment as a small portable gasoline engine and pump to insure tight connections under high pressure before placing them in service.

(6) That the city purchase necessary pitometers or recording meters to be used regularly to check the slippage of all operating pumps so that the pumping-station log sheet will show, when sent to the city engineer's office, the slip of the pumps at the last test and the actual number of gallons pumped each day. These meters with this type of log sheet, which is recommended in another report of the bureau, will help the operating engineers to keep the slip low and enable the city engineer to know the conditions of the pumps at all times so that the unaccounted-for consumption and losses can be accurately figured. When the fire-sprinkler systems, assessment-plan services, hydraulic elevators and public-consumption services are metered, the unaccounted-for consumption is practically reduced to an item of underground loss in the distribution system.

It is believed that the city should purchase the most practical operating meters for these slippage tests and at the same time be able to use the instruments through the summer months on water-survey work.

(7) That an appropriation of $10,000 be made to continue the water-waste survey work with an organization of engineers and laborers similar to the one that carried on the preliminary survey. The reduction of water losses and other beneficial results to the city which have been described in the report will make the expenditure a practical investment.

Bacterial Contents of Allegheny, Monongahela and Ohio Rivers at and below Pittsburg

In the course of the studies on which were founded the reports on sewage disposal at Pittsburg abstracted at length in our issue of Feb. 29 bacterial analyses of the river waters at and below Pittsburg were made. These studies were mentioned in our article just named, but it seems desirable to put on record a summary of the bacterial counts and a portion of Hazen & Whipple's comments on them, as follows:

"The accompanying figures show the probable average number of B coils per c.c. at various points in the rivers, as deduced from the weekly tests made for the year between Aug. 16, 1910, and Sept. 12, 1911, together with the average number of bacteria growing on gelatine plates.

"These figures show, first, a marked bacterial contamination of both rivers above Pittsburg; second, noticeably smaller numbers of bacteria in the Monongahela River than in the Allegheny River, due to the prevailing acid condition of the Monongahela water; third, a marked increase in the number of bacteria in the Allegheny River at the Sixth St. Bridge,

PROBABLE NUMBER OF B. COLI IN PITTSBURG RIVERS

	Estimated number of B. coli per c.c.	Number of bacteria per c.c. gelatine plate, 48 hr. at 20° C.
Sta. A—Allegheny River at Ross Pumping Sta.	23	15,000
Sta. B—Allegheny River at Sixth St. Bridge	358	104,000
Sta. C—Monongahela River at Brown's Bridge	11	3,500
Sta. D—Monongahela River at Smithfield St. Bridge	21	5,300
Sta. E—Ohio River at Stoops Ferry	118	7,900
Sta. F—Ohio River at Avalon, main stream*	83	14,400
Sta. G—Ohio River at Avalon, back channel*	30	9,700

*Ten months only

that is, just above the Point, and a smaller increase in the Monongahela River at the Smithfield St. Bridge, also just above the Point; fourth, a decided improvement in the bacterial condition of the water at the Ohio River between Pittsburg and Stoops Ferry. At Stoops Ferry the water of the Ohio River contained, on an average, fewer bacteria than the Allegheny River at the point where Pittsburg takes its water supply, and it contained only five times as many B. coli, a remarkable fact considering that the river receives all of the sewage of the city and that there were 15 times as many B. coli in the Allegheny River at Sixth St. as at the Ross pumping station.

"It is evident that the acid in the Monongahela water destroys many of the bacteria there, and that this reduction has an important effect on the bacterial content of the Ohio River below Pittsburg, making it lower than it otherwise would be. In addition to this, the natural purification by coagulation and sedimentation that takes place in the pools back of the dams during the summer is an important influence in reducing the number of bacteria in the river water at a time when the ground-water supplies are most likely to be overdrawn."

In the Search for American Potassium deposits, which is being pushed by the U. S. Geological Survey, a promising and important deposit of alunite has been studied near Marysvale, Utah. Alunite is a subsulphate of potassium and aluminum. It is insoluble, but may be readily made to yield a soluble potash alum, or potassium sulphate, by a simple process of roasting and leaching. The Marysvale vein seems to have an average width of 10 ft. for a total length of 3500 ft. neglecting the rest of the deposit which has not been sufficiently proved to be considered. The vein would have with these dimensions approximately 200,000 short tons of rock for each 100 ft. of depth, if the deposit maintains at increasing depths the present dimensions and quality. At least 10% of this total weight should be recoverable as soluble potash alum; this would mean a yield of 20,000 tons for each 100 ft. in depth, or from one-sixth to one-seventh the total annual consumption in the United States. This fixes the importance of the deposit.

A New Electric-Locomotive Design*

A new type of electric locomotive for general service has been built for the New York, New Haven & Hartford R.R. Each driver is connected to two single-phase 11,000-volt motors. Two center drivers are carried by the main locomotive frame which has deep girders outside of the journals. The outer drivers are carried in trucks borne between the ends of the main-frame girders.

The locomotive shown in the accompanying figures has recently been constructed for the New York, New Haven & Hartford R.R. by the Westinghouse Electric & Manufacturing Co., and the Baldwin Locomotive Works. It is now in service on the New York terminal division of the New Haven road. This design is a double Mallet type (there being two articulations), which has been called the "Colonial."

The locomotive, as shown, weighs 116.5 tons and will develop a tractive effort of 12,000 lb. continuously at a speed of 35 miles per hour. It may be used, however, for hauling heavy passenger trains at speeds up to 50 miles per hour. The figure given for weight includes that of an oil-fired car-heating boiler, water tank, and direct-current control equipment. Without this apparatus the weight is about 108 tons.

*From information furnished by the Westinghouse Electric & Manufacturing Co., Pittsburg, and the Baldwin Locomotive Works, Philadelphia.

It will be seen from Fig. 2 that the main locomotive frame consists of two deep plate girders outside all the journals, together with four cross girders between drivers and two heavy end bumper castings. The main girders are of ⅝-in. steel plate, 34 ft. 4 in. long and 36 in. deep at the center. The edges are stiffened with 3x4-in. angles. The web plate has been cut out as shown to promote access to the journals, etc. The main frame carries the journals for the two center drivers in pedestals riveted to the inside of the long girders; the center rigid wheel base being 11 ft. These wheels can be removed by jacking up the frame, which is made strong enough to carry the center drivers and motors, in addition to the upper works and when supported at the four corners.

One pair of drivers and a pair of pony wheels, with a proper frame, constitute a four-wheeled radial truck which is placed between the main girders and under the end bumper castings. This truck has a wheel base of 84 in.; the total wheel base

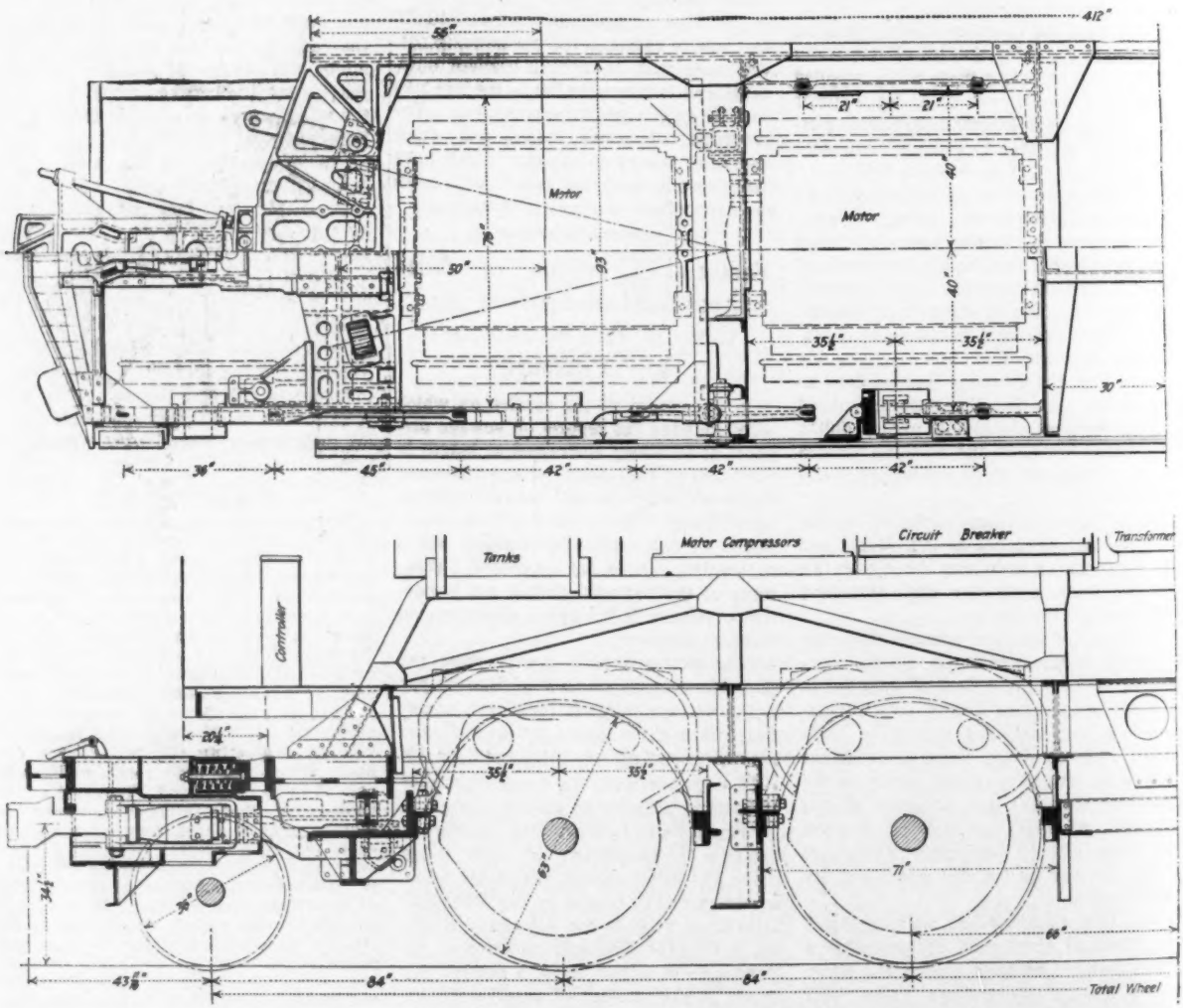


FIG. 2. HALF PLAN AND ELEVATIONS OF

of the locomotive is 39 ft. and the length between coupler knuckles is 46 ft. 8 in.

The couplers, platforms and buffers are carried on the trucks, as seen in Figs. 2 and 3. The impact stresses are first received by the trucks through the coupler retaining casting, and are transmitted to the main bumpers and frames by a spring buffer located above and back of the draft gear, but with a motion limited to about ¾ in. The truck further engages the main frame, where two lugs on the truck back crosstie are held between two curved chafing plates on the main frame. This also provides the proper articulation. The faces of these lugs are machined as of a cylinder whose radius is the virtual radius of the truck articulation.

Each truck carries two link bars connecting an extension pedestal on the middle cross frame of the truck with a pin in the superimposed bumper casting of the main frame. The forward end of each link bar is slotted to allow proper play in buffing. Their function is to act on both drawbars and radius bars.

The cab is integral with the main frame, and serves only to house the transformer control and other equipment. The most of this apparatus is supported by a trussed frame which bears directly on the bumpers of the main locomotive frame. The floor, sides and roof are light and carry only a few small pieces of apparatus.

Part of the main-frame load, of course, is carried directly to the center-driver journals; the rest is transmitted to the trucks by the bumpers of the main frame. Between the bumper and the center cross frame of the trucks are interposed two eccentric beveled and toothed rollers engaging with an overhead rack plate. The axes of these rollers are inclined to the center line of the locomotive as seen in Fig. 2, so that they intersect it at the center (virtual) of the truck articulation. The eccentricity of the rollers produces a tendency for the truck to return to mid-position, and the work done in lifting the end of the frame is claimed to prevent oscillations.

The general scheme of equalization is seen from Fig. 4. This shows that the truck and main-frame load are equalized together, but without cross-truck equalizing. To accommodate movement between the truck and frame without disturbing the equalizing mechanism, two beams of each side are hinged in the plane of the beam. Details of the hinge are shown in Fig. 5. The hinge pin is shown inclined to the vertical about 20° so that the beam, when deflected, will always tend to straighten. It will then always be in proper position when the locomotive is on tangent track. The under equalizer beams are all solid bars, while the upper ones are leaf springs.

The motors are mounted above the drivers and this with the auxiliary-apparatus truss-frame support results in a high center of gravity. The most important outside dimensions may be summarized as follows:

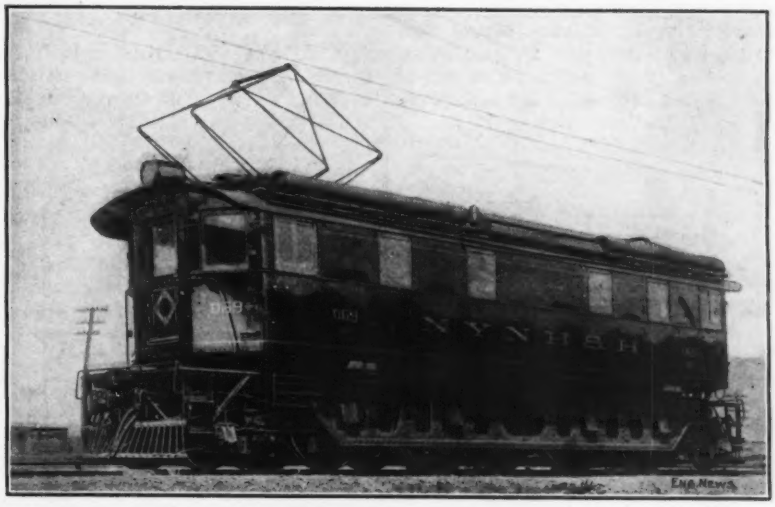
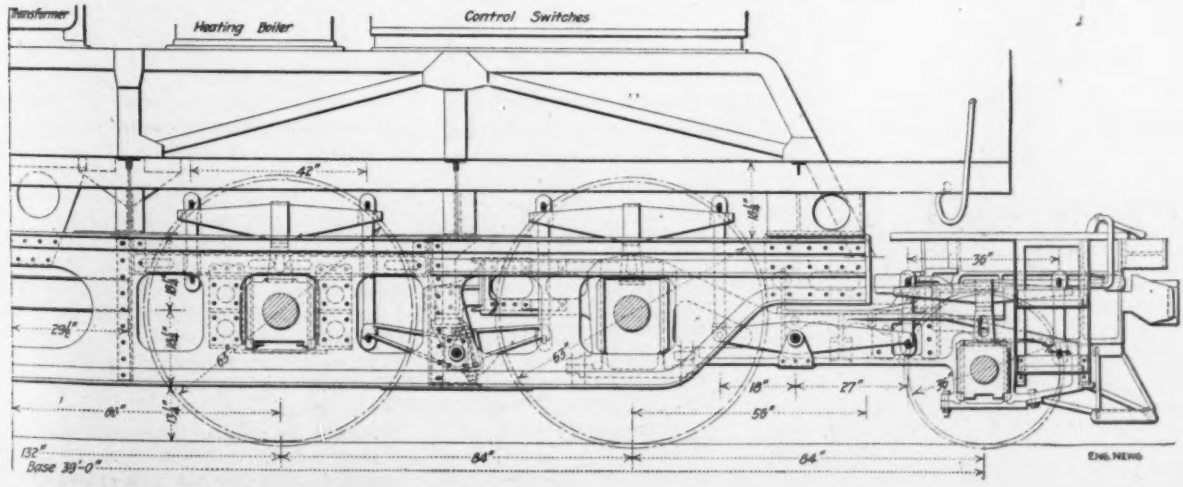


FIG. 1. A DOUBLE-MALLET ELECTRIC LOCOMOTIVE

(Built for the N. Y., N. H. & H. R.R., by the Westinghouse Electric & Manufacturing Co. and the Baldwin Locomotive Works.)

Center wheelbase	4 ft.
Truck wheelbase	7 ft.
Total wheelbase	39 ft.
Length between coupler knuckles	46 ft. 8 in.
Width over all	10 ft. 3 in.
Height to top of cab	13 ft. 9 in.
Diameter of drivers	63 in.
Driver journals	8½x11 in.
Diameter of pony wheels	36 in.
Pony journals	6½x11 in.

The electrical features follow the lines already developed for the New Haven road—11,000-volt single-phase current received overhead at the locomotive and there transformed to 600 volts for each motor, also 600-volt direct-current control provided for running on the third-rail system leading into Grand Central Terminal, New York City.



"COLONIAL" TYPE OF ELECTRIC LOCOMOTIVE

The two motors for each driver are permanently connected, giving on alternating current the effect of a single high-voltage motor, reducing the size of cables and the controller losses. For operations on the 600-volt direct-current section, the two motors are still kept in series and the four motor groups are connected up in the same control steps as the four motors of a standard direct-current equipment series, series-parallel and parallel. The motor is a series compensated type with resistance leads between the commutator and armature windings. The one-hour rating is 170 hp., and the continuous-service figure is 145 hp.

FIG. 4. DIAGRAM OF EQUALIZATION: "COLONIAL" TYPE OF ELECTRIC LOCOMOTIVE

Each pair of motors weighs 11,900 lb., being somewhat lighter and cheaper than a single motor of their combined capacity. Each of the twin motors has twice the rotative speed of the motor that would have to replace them and half the number of poles, so that there are practically the same number of running parts like commutator bars, armature coils, brushes, brush-holders, etc. The reduction in weight arises from the diameter of the small motor being about half that of the larger one needed, permitting lighter frames and housings. Both pinions on the two small motors mesh with the same gear, so that only one large gear is required for each driving axle, compared with two for the alternative large motor which would require a pinion on each end of the armature shaft. The twin gears on a single large motor demand length of space between wheels needed for the motor itself, the loss necessitating further increase of diameter and weight; thus, the two small motors better utilize the space available between wheels.

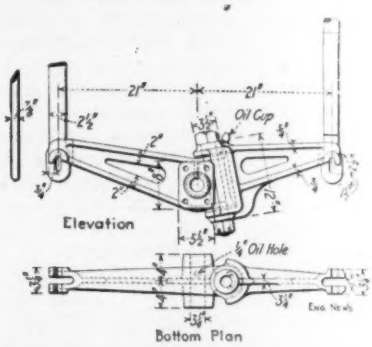


FIG. 5. DETAIL OF HINGED EQUALIZER BEAM

The motors and main transformer are cooled by air from two motor-driven blowers, each capable of supplying 6000 cu.ft. of free air per minute. There are two 50-cu.ft. motor-driven air compressors for the brakes, sanders, pantograph and third-rail-shoe cylinders, etc. These working parts are controlled by magnet valves and push-button circuits.

While it is expected that one locomotive will be able to haul the heaviest train to be encountered, yet it has been fitted with a control train line and jumper heads so that two units can be operated in parallel by one engineer.

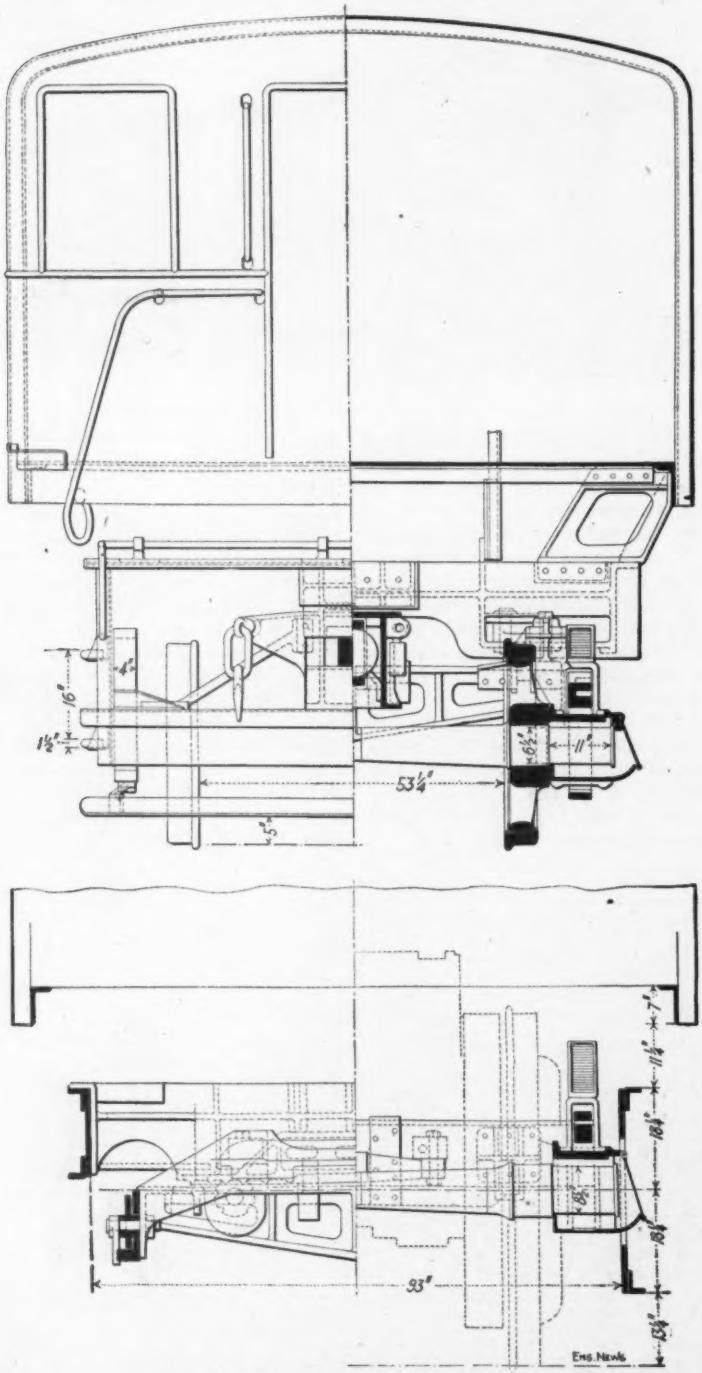


FIG. 3. CROSS-SECTIONS OF LOCOMOTIVE

A Centrifugal Pump for Unscreened Sewage

A novel centrifugal pump has been invented by Sir R. C. Parsons, of steam-turbine fame, for raising unscreened sewage. He has given his pump the odd name of "stereophagus" ("eats them whole") from its ability to pump water containing large quantities of cotton waste, wood shavings, rags, rope, wood, cork, brick and other solids usually found in unscreened sewage. The inventor states, in a pamphlet recently issued, that he was led to the design of this piece of apparatus after he had designed and constructed a large hydraulic sewage-pumping installation in Buenos Aires, South America. It was necessary to make a number of separate districts and to raise the sewage by Shone pneumatic ejectors from the low points. Mr. Parsons desired to secure a pump which would lift the sewage without preliminary screening and operate more efficiently than the pneumatic ejector.

Figs. 2, 3 and 4 show the construction of this pump. The impeller differs from that of the ordinary centrifugal pump by being made conical instead of cylindrical, and the liquid is admitted to only one side of the impeller. This gives opportunity for a wide firm bearing with an overhanging impeller. Surrounding the periphery of the impeller and in the same position as in an ordinary centrifugal pump, is a spiral chamber leading to the outlet pipe. The casing on the inlet side of the pump is formed so as to fit the face of the impeller. By advancing the shaft of the impeller, from time to time as occasion demands, any extra wear can be compensated for.

On the front side of the casing, and integral with the cover casting is a cylindrical chamber into which fits a holder bearing a steel knife. The edge of this knife, which projects toward the impeller, is given a slope so as to coincide with the angle of the edge of the impeller blades. On the interior of the inlet pipe and projecting as far as its center, close to the impeller, is a fin, which is gradually increased in height, as shown. The upstream edge of the knife described is in line with the fin, and the point of the former nearly coincides with the center of the impeller.

The action of the device is like that of an ordinary centrifugal pump, so far as its pumping function goes. Any solid materials in the liquid too large to pass freely through the pump are guided along the inlet by the fin and come in contact with the blades of the impeller, being then carried around until they reach the edge of the knife where they are sliced up until their size is reduced sufficiently to pass along the impeller passages.

The passages between the blades at the point where the cutting takes place are seen to be of smaller dimensions than those farther along toward the outlet, so that any solid which can pass the knife cannot become lodged in the impeller passages. There is also a spiral groove in the face of the casing cover, so that in the event of any solids becoming jammed between the edges of the blades and casing they will eventually be worked into this groove and out with the liquid. On account of the curve of the blades, the cutting action of the impeller and knife blades is like a pair of scissors and there is no appreciable shock when any solid is sliced.

Tests of one of these pumps were made by Prof. C. F. Capper, of King's College, University of London, at the works of the Pulsometer Engineering Co. The accompanying test data are taken from his report. The device is being introduced by the inventor, Sir R. C. Parsons, 39 Victoria St., London, S. W.

TEST RESULTS; PARSONS "STEREOPHAGUS" CENTRIFUGAL PUMP

Cu.ft. per sec.	R.p.m.	Total head, ft.	Hp. output	Hp. input	Total motor belt and pump-bearing loss	Pump-bearing loss	Motor belt and flywheel	Net hp. to pump	Pump efficiency
0	592	0	0	2.65	2.65	0.13	....	....	....
0	580	24.0	0	5.94	2.65	0.13	2.52	3.42	0
0.03	577	24.4	0.61	6.18	2.65	0.13	2.52	3.66	16.7
1.48	577	23.7	2.97	8.27	2.65	0.13	2.52	5.75	51.5
2.30	569	17.9	3.47	9.40	2.65	0.13	2.52	6.88	50.3
2.5	565	16.4	3.45	10.35	2.65	0.13	2.52	7.83	44.2

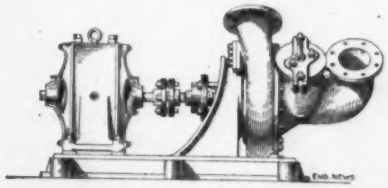
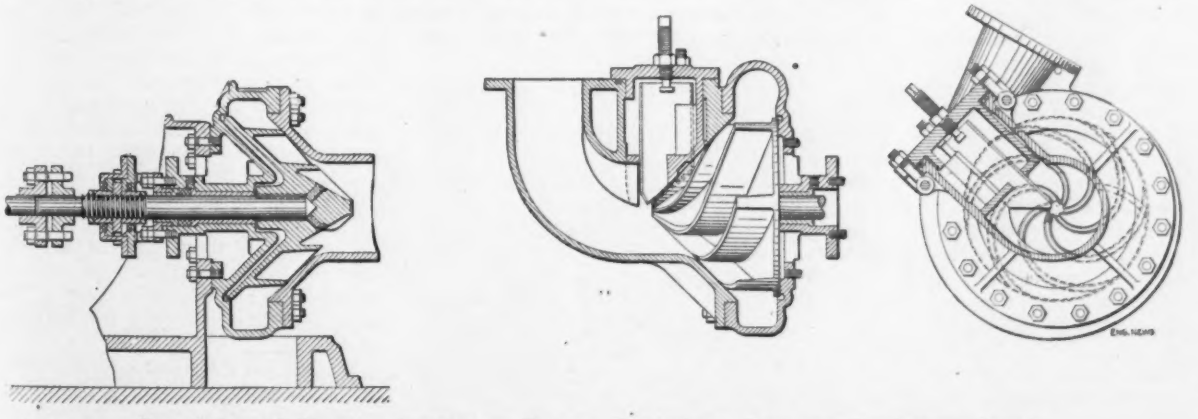


FIG. 1. THE PARSONS "STEREOPHAGUS" PUMP, MOTOR DRIVEN

To Improve Building Inspection, a change in the organization of the inspecting force has been made by R. P. Miller, Superintendent of the Bureau of Buildings of Manhattan, New York City. Hitherto the inspection has been done by one inspector to each inspection district. This man had to inspect all current new construction, alterations and minor work, and also investigate complaints, applications for repairs, etc., and maintain a general patrol of his district to discover unauthorized work and the like. With such a diversity of duties the inspection of new construction suffered, conditions frequently making it necessary to give the other duties precedence. In future the inspection of new work and important alterations will be separate from the other duties, and each of the two classes of duties will be handled by a separate man. The construction inspection will not be handled by districts, but each construction inspector will be assigned such an amount of work as he can cover efficiently. The other inspectional duties will continue to be handled by district inspectors, but the districts will be made larger than those established heretofore.



FIGS. 2, 3 AND 4. SECTIONS THROUGH THE PARSONS CENTRIFUGAL PUMP FOR UNSCREENED SEWAGE

An Improved Distributor for Heavy Road Binders*

The combined tank wagon, heater and distributor shown in Figs. 1, 2 and 3 has been designed by the Good Roads Machinery Co., of New York City, to facilitate and cheapen the application of heavy bituminous material to broken-stone roads. A feature of particular interest is the arrangement for heating the delivery pipes so that the binder has no opportunity to cool before the moment of actual discharge onto the road.

The machine consists of an inner tank of 350 gal. capacity, made of heavy boiler steel, enclosed in an outer casing of common sheet steel. On all sides and ends of the tank there is a fire space varying from 2 in. in width at the top of the sides to 12 in. underneath.

To this tank is connected by means of a 4-in. pipe a new patented distributor head. As the machine is designed especially for spreading the heavy binders, this head also is encased so that the hot gases from the fire box may be passed over it. The 4-in. pipe divides and leads to two header castings, which discharge the hot bitumen through a number of small openings onto adjustable converging apron plates. The opening between these aprons is submerged, between wide discharge limits, and the material flows out in an unbroken sheet. From ⅓ to 2 gal. per sq.yd. can be successfully laid, it is claimed.

The machine is mounted on a steel frame and iron running gear. In order to prevent rutting the road surface the wheels are equipped with 6-in. tires in front and 8-in. ones in the rear. The loading hole on top of the tank is covered with a fine-mesh screen to prevent the entrance of foreign matter which would clog the valves. When the distributor is to be used on grades, a tire brake is attached and hand operated from the driver's seat. The front truck can be steered by a handwheel when desired, as when hauled by a road roller, but this can be thrown into or out of action easily. An indicator rod is attached to either side of the machine so that they trace on the road, in plain view of the driver, the path of the edge of the sheet of binder. This scheme has prevented overlapping coats or leaving uncoated streaks.

This distributor is not intended for the first melting of the binder to be used. This is to be done in portable tanks or pans and the molten material pumped into the distributor. However, if desirable, part of a charge may be left overnight in the tank and quickly remelted. The firing door is just back of the front wheels.

As will be seen later from the construction notes appended, the operation of the melting tanks or pans greatly affects cost of distribution by permitting or preventing use of the machine at full capacity.

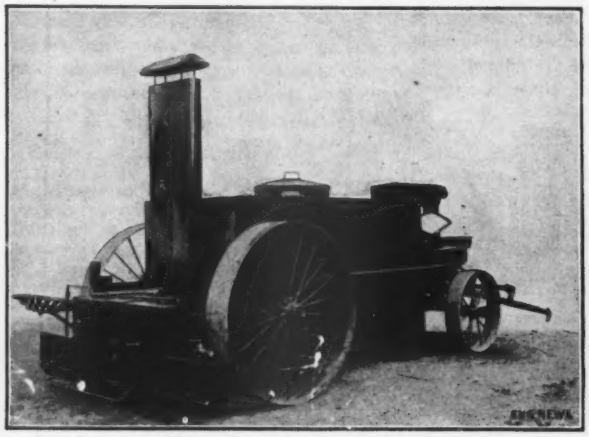
For use with this distributor two melting outfits of simple design, are recommended. The pans themselves are of sheet steel with angle-iron legs at each end and a pair of high wheels at the center. They will hold 13 bbl. or 650 gal. of binder and two men with two pans can easily supply 600 gal. per hour. A wood fire is built under the pan.

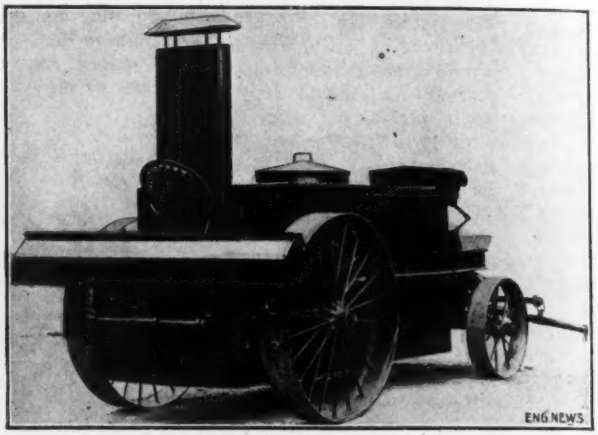
The skids used are about 2 ft. longer than needed to reach the edge of the pan so that a barrel can be rolled up, turned and balanced while the heads and staves are knocked off. Then further raising the lower end of the skids allows the chunk of binder to be slid into the pan without splashing. If the material is too sticky to free the staves and heads, these are dumped in with the binder and fished out later. In warm weather when the binder becomes still more plastic, bars are placed across the top of the pan and the barrels are turned end up on them after the heads are knocked in. This is slower and a few barrels have to be drained at once to secure full capacity of the pan.

It is claimed that under ordinary working conditions, more than six times as much binder can be poured per hour as with hand pots. To substantiate this claim and to show actual use, the following cases have been cited:

ROAD CONSTRUCTION, PLEASANTVILLE, N. Y.—Penetration method; Bermudez asphalt, first coat ¾ gal. per sq.yd., second coat ½ gal., temperature 300° F.; distributor hauled by team on levels and by steam roller on grades; two heating pans used.

Working Conditions: Road built in late fall with average temperature of 40° F.,





FIGS. 1 AND 2. HEATING DISTRIBUTOR FOR HEAVY ROAD BINDERS
(Built by Good Roads Machinery Co., New York City.)

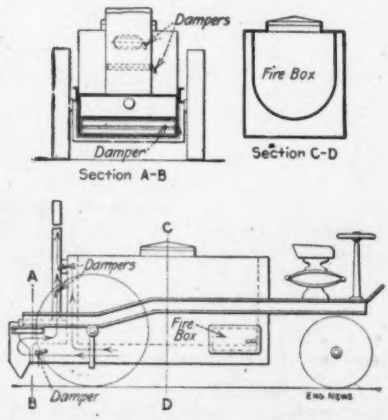


FIG. 3. DIAGRAM SHOWING ARRANGEMENT OF HEATING DISTRIBUTOR

(Dotted line shows path of hot gases when distributor is ready for pouring; dash line shows the path with distributor head raised.)

*From information furnished by W. G. Harrington, highway engineer of the Good Roads Machinery Co., 18 Old Slip, New York City.

hindering rapid heating in pans. Half the length on grades of over 6%; center of the road a series of sharp curves, with sharpest curves and steepest grades combined; rainy weather interfered; 1000 linear feet of 14-ft. strip prepared in advance with top course and chips piled alongside to permit completion of 1000 ft. per day; 2000 gal. spread per day.

COSTS PER DAY

3 men at pans	$6.00
1 operator	2.50
1 team and driver	6.50
	$15.00

No charge for fuel or roller.

ROAD CONSTRUCTION, MONTCLAIR, N. J.—Penetration method; Bermudez asphalt, first coat 1¼ gal. per sq.yd., second coat ¾ gal., temperature 325°-350° F.; distributor hauled by two-horse team; two heating pans used.

Working Conditions: A 6-in. clay-filled Telford base was covered with 3 in. of 2-in. stone, well rolled; first coat of binder followed with less than 1 in. of ¾-in. stone and rolled with 12-ton roller; second coat covered with screenings and rolled; cord wood and barrel staves used for fuel; work delayed by inability of contractor to spread stone fast enough; because of dew it was not possible to pour before 11 a.m., any day; last load poured before 5 p.m.; an average day's work was the completion of 1600 ft. of 16-ft. strip; average time of pouring one load of 350 gal., 10 minutes; one load pumped from pan into distributor in 12 min.; 2200 gal. poured per 6-hour day compared with 600 gal. by hand in 10 hours.

COSTS PER DAY

2 men at pans	$4
1 operator	2
1 team and driver	6
1 load fuel	1
Supervision	5
Total	$18

Average cost per gallon high because of charge for supervision and long waits in morning.

ROAD CONSTRUCTION, LATTA ST., CHARLOTTE, N. C.—Penetration method; "Texaco" road asphalt, first coat 1¼ gal., second coat ½ gal., temperature 325° F.; distributor hauled by steam roller; one heating pan used.

Working Conditions: Stone and screenings furnished as fast as required for completion of 500 linear feet of 30-ft. street per day; only one pan obtainable; steam road roller used to haul distributor; sticky condition of binder required excess time for draining barrels; colored labor; team used to haul distributor from pan to roller; 2000 gal. spread per day of 10 hours.

COSTS PER DAY

2 men at pan	$2.50
1 operator	3.00
1 team and driver	3.00
Total	$8.50

No charges for roller and superintendence.

A Code of Ethics and Schedule of Fees for Consulting Engineers

The Pacific Association of Consulting Engineers, recently organized with a charter membership of 22 prominent engineers, most of them residing in San Francisco,* has adopted the following "Code of Ethics" and recommends the "Schedule of Fees" given below:

CODE OF ETHICS

1. It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member of The Pacific Association of Consulting Engineers

(a) To act for his clients in professional matters otherwise than in a strictly fiduciary manner, or to accept any other remuneration than his direct charges for services rendered his clients, except as provided in Clause (d).

(b) To accept any trade commissions, discounts, allowances or any indirect profit or consideration in connection with any work which he is engaged to design or to superintend, or in connection with any professional business which may be entrusted to him, save with the full knowledge and consent of his client.

(c) To neglect informing his clients of any business connections, interests or circumstances which may be deemed as influencing his judgment or the quality of his services to his clients.

(d) To receive, directly or indirectly, any royalty, gratuity, or commission on any patented or protected article or process used in work upon which he is retained by his clients, unless prior to the use of the same he shall have notified his clients that he is entitled to such royalty, gratuity or commission.

(e) To offer commissions or otherwise improperly solicit professional work either directly or by an agent.

(f) To atempt to injure falsely or maliciously, directly or indirectly, the professional reputation, propects or business of a fellow engineer.

(g) To accept employment by a client while the claim for compensation or damages, or both, of a fellow member previously employed by the same client and whose employment has been terminated, remains unsatisfied, or until such claim has been referred to arbitration, or issue has been joined at law, or unless the member previously employed has neglected to press his claim legally, excepting with the written consent of the fellow member.

(h) To attempt to supplant a fellow engineer after definite steps have been taken towards his employment.

(i) To compete with a fellow engineer for employment on the basis of professional charges, by reducing his usual charges and attempting to underbid after being informed of the charges named by his competitor.

(j) To accept any engagement to review the work of a fellow member for the same client, except with the knowledge of such member, unless the connection of such member with the work has been terminated.

2. For the purpose of improving present court procedure in its relation to engineering practice, and for the purpose of increasing the efficiency of the engineering profession as an aid to the settlement of questions in controversy, this Association believes it desirable to restrict such engagements as soon as practicable to the following conditions:

(a) As a witness when appointed by and compensated through the agency of the Court.

(b) As Court commissioner, referee or other examiner, preferably sitting with an attorney, to take evidence involving engineering questions.

(c) As arbitrator appointed by either party to the controversy, or by both parties jointly through the agency of the Court or otherwise, and compensated by both parties conjointly.

(d) As special advisor to either contestant.

This association advocates the early adoption of such changes in the methods of court procedure.

3. Members are to have the right at any time to receive from the Board of Governors an interpretation of this code of ethics in application to difficult and unusual cases.

SCHEDULE OF FEES

As a general guide in determining fees for professional services, the Pacific Association of Consulting Engineers recognizes the propriety of charging: A—A per diem rate; B—A fixed sum; C—A percentage on the cost of work.

A—Per Diem Rate—Charges for consultation, reports and opinions should vary according to the character, magnitude and importance of the work or subject involved, and according to the experience and reputation of the individual engineer, from $50 per day to a higher figure; and in addition, where conditions warrant, a suitable retainer. An additional charge is to be made for all actual expenses such as surveys, traveling and general office expenses.

B—Fixed Sum—A fixed total sum for the above mentioned services may be agreed on in lieu of per diem charges.

C—Percentages on Cost of Work—1. For making preliminary studies working drawings, specifications and contracts, and for the general direction and supervision of the work, in lieu of a per diem or a fixed sum the minimum charge shall be five per cent. upon the entire cost of the work, exclusive of legal and administration costs.

2. For work costing less than $20,000 or of unusual complexity of design, it is proper to charge a special fee in excess of the above.

3. Consultation fees for professional advice are to be the subject of special agreement.

4. Payments to the engineer are due as his work progresses: upon completion of the preliminary design of an original project or for the examination and report upon a project prepared by another engineer, one-fifth of the entire fee; upon completion of working drawings and specifications, two-fifths; the remaining two-fifths being due from time to time in proportion to the work done at the office or at the site.

General Provisions—1. Until the actual cost of work is determined, the charges shall be based upon the estimated cost.

2. Necessary traveling expenses shall be paid by the owner.

3. Changes in plans and specifications ordered by the owner shall be paid for by the owner; the additional fee to be based upon the amount of the cost involved in the change.

*See Eng. News, of Mar. 7, 1912, p. 464, for further information concerning this Association.

4. All chemical, physical and mechanical tests, examination of sites, etc., are to be paid for by the owner.

5. In case of abandonment or suspension of the work at any time, an adjustment of the fee shall be made on the same basis as that of the partial payments hereinbefore stated.

6. If any material or work used in the construction of the project be already upon the ground or come into the owner's possession without expense to him, its value shall be included in making up the total amount upon which the fee is determined.

7. It is recognized that in any work undertaken by an engineer there may be problems requiring the services of a specialist. The cost of such special assistance shall be paid by the owner.

8. Contract forms shall, when requested, be prepared by the engineer; but all legal services connected therewith, together with all services, legal or otherwise, incidental to purchase of rights of way, failure of contractors, disputed contracts and work of such order, shall be paid for by the owner. The engineer shall render all necessary assistance in the way of explanation of his work.

9. It is recognized that engineers may with propriety undertake all the work in connection with a project including business, legal and other matters, in which case the fee shall be the subject of special agreement.

New Paper Specifications for the Government Printing Office

Purchase of the large quantities of paper required for the Government Printing Office has recently been put on a more businesslike basis by the Congressional Joint Committee on Printing. The committee established an expert board, the Printing Investigation Commission, including representatives from the printing office, the Bureau of Standards, and the Bureau of Chemistry. This commission was charged with the duty of examining the specifications for paper hitherto used by the printing office, and preparing revised standard specifications and standard paper samples for making paper contracts for the current year. It was also required to report uniform methods of testing paper for acceptance.

At the root of the matter was the question of "loading" paper with clay and other fillers. The allowable limit of "loading" has hitherto not been definitely specified in the contracts of the Government Printing Office, and serious differences arose between the printing office and manufacturers of paper over certain rejections of paper shipments, leading to protests by the manufacturers to the committee. In the hearing on these protests it was found that contracts before this year did not mention loading, and this was covered, if at all, only by the general term "quality"; what limit of loading would be accepted could be inferred only from the standard sample attached to the contract. However, the standard samples were not in all cases uniform, that is to say, the sample under which the manufacturer was delivering was in some cases different from the sample on file at Washington, particularly in the matter of loading or weighting.

The chief work of the Printing Investigation Commission was to decide upon the requirements desirable for different uses of paper, to specify these requirements definitely, and to provide means for testing the paper to reach these requirements. The functions of the commission were broad enough, however, to include also the selection of grades of paper suitable for the work of the printing office, and the commission was able to reduce considerably the number of kinds of paper ordered. As an important innovation, news print paper was placed upon the list, to be used for those publications which are of very transitory character. The news print paper may contain up to 70% of ground wood, while the next printing class, machine-finish printing paper, is an all-chemical wood paper of first ffuality, and is expected to have a life of at least 25 to 30 years, as against two or three years for the news print paper; the difference in price is quite material. At the same time the list was added to by including a higher-grade paper than has before been ordered, for use in those publications which contain scientific and technical matter forming original contributions to knowledge or other material which should be preserved indefinitely, or publications which are to be subjected to frequent handling and severe uses. There were several minor innovations also, such as including a paper coated on one side only, for use for illustrations printed on one side only, the paper previously used for this purpose having been coated on both sides.

Some of the important points relating to quality of paper which the commission discusses are as follows:

WEIGHT—Referring to "the tendency to use an unnecessarily heavy paper," the commission has reduced the weight of paper called for, wherever practicable. The commission is of the opinion that "as a rule, publications and documents of all kinds are both unnecessarily heavy and bulky." While decrease in the weight usually will involve some decrease of opacity, the weights specified are believed to secure a satisfactory degree of opacity.

MINERAL FILLER OR LOADING — The specifications were drawn so as to limit filler to an amount sufficient for the required degree of opacity and finish. The commission remarks: "An increase in filler is accompanied by the reduction of the amount of fiber stock present in a given weight, and a decrease in the strength, durability and life of the paper." For the important grades of paper, the majority of the committee agreed in the opinion that the following limits are adequate:

For machine-finish printing paper, 5% ash (alternative specifications allow a 10% maximum, to get a comparison of prices); sized and supercalendered printing paper, 8% (alternative 15%); coated book paper, 25% for single-coated, 30% for double-coated; postal-card bristol board, 5%.

STOCK—While for the highest grade of paper the committee has specified 50 to 100% of rag in the material, the amount of rag being readily determinable by the microscope, the committee considers that the important question of the quality of rag used must be judged by the bursting strength of the paper. The specifications, therefore, fix the bursting strength on all important permanent papers sufficiently high to guarantee not only good strength, but the use of good rag stock. For one of the important grades of permanent paper the committee has made alternate specifications, requiring 50% and 75% of rag, to determine the difference in cost.

SAMPLING AND TESTING—Samples for for testing are to be selected by the printing office from deliveries, in sufficient number to get a satisfactory record of the material delivered. The samples are to be tested at a relative humidity of 65% and temperature of 65° F.

Representative samples are to be tested physically, microscopically and chemically; and by inspection to determine suitability of color, finish, formation, writing and printing qualities, freedom from dirt, specks, etc.

The bursting strength is to be determined with a machine by which the paper is firmly clamped against a rubber diagram through which pressure is applied to a circular area of the paper measuring 1 sq.in. The pressure required to burst the paper is registered on a gage reading in pounds per square inch.

FOLDING RESISTANCE—This is not specified quantitively, but for those papers for which it is important the specifications merely require that "the folding quality must be good."

As representative of the requirements made by the specifications, some specimen papers are cited below:

NEWS PRINT PAPER—Weight, 25x40, 500—40-lb. basis; Thickness, not over 0.0033 in.; Strength, not less than 10 points; Stock, at least 30% sulphite, the remainder may be ground-wood pulp; Ash, not exceeding 5%. To be delivered in rolls, width from 9½ to 48 in.

SINGLE-COATED BOOK PAPER (One Side)—Weight, 25x40, 500—76-lb. basis; Thickness, not over 0.0035 in.; Strength, not less 16 points; Stock, may be bleached chemical wood, free from unbleached or ground-wood pulp; Ash, shall not exceed 30%; Sizing, the total rosin shall not exceed 4%; Folding Quality, must be good; Coating, shall not flake, pick, lift or pulverize.

FIRST-CLASS LEDGER PAPER—Weight, 25x40, 500—100-lb. basis; Thickness, not over 0.0065 in.; Strength, not less than 85 points; Stock, 100% rag; Ash, not over 1%; Sizing, rosin not over 2%. Must have good erasive qualities.

U. S. POSTAL CARD BRISTOL BOARD—Weight, 25x40, 500—165-lb. basis; Thickness, not less than 0.009 in., not more than 0.01 in.; Strength, not less than 50 points; Stock, may be bleached

chemical wood, free from unbleached or ground-wood pulp; Ash, not over 5%; Color, finish and formation: the paper must be firm, snappy, and free from curl or flimsiness, and of a uniform color subject to change by the Public Printer; it shall be clean, free from dirt, specks, fuzz, and discoloration; and without water finish, crushed spots, or calender marks. It must be suitably sized, uniformly run, calendered, and finished on both sides with a smooth, even, firm surface, suitable for writing with either ink or pencil and for printing.

STEREOTYPE MOLDING PAPER—Weight, 25x40, 480—176-lb. basis; Thickness, not over 0.02 in.; Strength, not less than 35 points; Stock, not less than 75% rag, the remainder may be bleached chemical wood, free from unbleached or ground-wood pulp; Ash, not over 5%.

DIMENSIONS—The committee finds that the printing office requires a large number of sizes of paper, and expresses the hope that with the coöperation of all government departments and bureaus a great reduction in the number of sizes of sheet may ultimately be reached. Attention is called to the fact that the sizes of government documents vary greatly without any special necessity.

It has been found practically impossible to reduce the number of sizes carried in the various classes of paper of different weights. This could only be accomplished by a very vigorous movement to standardize the sizes of Government publications, a reform which is very much needed. It is confidently believed that a well directed effort on the part of the Joint Committee on Printing to standardize and unify the uses of the paper in the printing and binding under its direction would lead to efficiency, economy and progress in the Government's great publishing activities.

The members of the Printing Investigation Commission were: Chairman, D. E. Douty, of the Bureau of Standards; F. C. Veitch, of the Bureau of Chemistry; H. P. Brian, Deputy Public Printer; Geo. H. Carter, clerk of the Joint Committee on Printing; W. R. Bradford; H. L. Strawn, inspector for the Joint Committee on Printing. The printing committee of Congress is under the chairmanship of the Hon. Reed Smoot, Senator from Utah.

A Safety-valve Discharge Register for locomotives has been devised for the purpose of reducing the loss of steam (and fuel and water) caused by excessive blowing off the valve. It consists of a timing apparatus which is started automatically by a lever when the valve lifts; when the valve closes, this lever returns to its normal position and the apparatus stops. The dial is graduated for time and for loss of coal and water, the device being calibrated to show these amounts. There are two hands, and at the end of a run the time that the valve was open and the loss of coal and water in that time can be read from the dial. The device is the invention of F. J. Zerbee, Master Mechanic of the Cleveland, Cincinnati, Chicago & St. Louis Ry., at Bellefontaine, Ohio, and 23 engines on his division are equipped with it. He informs us that for the first month it was tried in service, the average time the valve was blowing off was 3 hr. 30 min. for a 280-mile run. Later on, the firemen were informed of the purpose of the register, and were instructed to eliminate all unnecessary popping and blowing off. In the course of six months, the average time that the valve was blowing off on the same 280-mile run was 1 hr. 20 min.

Reform in Technical College Methods*

By J. W. Ledoux†

In discussing the subject of possible reforms in technical education, it is first necessary to define the object of education, and it may be stated that the best education is that which has the farthest reaching effect in advancing the human race. The upward progress of humanity from the lowest stage has been due to natural selection, discovery and invention. Then technical education should concern itself with the equipment and training which will best enable the student to be resourceful and inventive, because there is no business requiring engineering or technical ability that is not capable of material advancement through invention and discovery.

From infancy the principal business of life consists in working out problems. They may not be mechanical or mathematical, but a similar process of the mind is brought into play when planning methods of scientific management or the organization of a trust. Therefore, let us not forget the importance of practice in applied mathematics for this purpose. It might be said that mathematics is to the mind what physical exercise is to the body.

It has been suggested that technical students should take up mathematics only as far as quadratics. For the man of average education, who makes no pretense to technical training, this contention has a point to it, and certainly a great many college graduates are not any too efficient in algebra and the lower branches of mathematics; so that if we were absolutely certain that the graduating engineer were thoroughly skilled in elementary mathematics, such as arithmetic, geometry and algebra up to the end of quadratics, the results might be better than even now. There are so many men who go through college and get only a smattering in the lower branches, that it would be far better if they were thoroughly instructed in their simple mathematics and did not know anything at all about higher mathematics.

However, no engineer who is to practice his profession in anything like an extensive manner can be considered well equipped unless he has a good deal more mathematics than is obtained up to quadratics. A business man does not come to an engineer for advice upon something that the ordinary business man understands, and when he does come to him with a mathematical question he expects him to be able to give a definite solution.

It might be gathered from the above that I am advocating an extensive study of mathematics, but this is not my purpose at all. All that is recommended is sufficient to fit the civil engineer for the practice of his profession. The engineer proper, however, uses arithmetic every day, algebra once a week, geometry and trigonometry once a month, and calculus, say once a year, and in some of his special problems may need it frequently. If he does need it he needs it badly, and unless he has or once had a working knowledge of it he might as well not know it at all. The fact that these things are needed less frequently is not a sufficient excuse to drop them entirely, because when they are needed, their importance is so great that the ability or inability to handle them may be the turning point in the career of the engineer.

Where an engineer has a working knowledge of his calculus and the confidence due to this ability, he will very often successfully essay an accomplishment which would not be attempted by one with a superficial knowledge of the subject. To my mind the study of calculus affords an education in itself. If one is thoroughly interested in the subject and gets a fair understanding of its vital principles, his mental nature undergoes a transformation something akin to that of the first discoverer that the earth was round and traveled around the sun in a regular orbit. He begins to understand the principle that all things are everlasting, and that there is no such thing as absolute in matter, space or force—that all is relative. It enables him to perceive the infinite in what appeared to him before as the most commonplace detail.

As every phenomenon is the result of force acting upon matter according to one or more of the immutable and eternal laws of nature, it would seem that the only form of education that is worth while is the study, not of the phenomena, but the matter, force and laws of which the phenomena are a result.

Some people would have us believe that an engineer should be thoroughly informed upon jurisprudence and the laws of business, laws of agency, etc., but all these things are capricious and devices of man which change from day to day, and no matter how well the engineer is versed in such subjects, no business concern will entrust him with any such question. The lawyer with his special training is always called in if the matter is of any consequence. Therefore, I think the time devoted to legal matters in college is simply wasted.

The subject of political economy is one of the most vital importance and one in which the fundamental principles appear to be entirely discredited by the majority of people; otherwise the widespread poverty and unrest among the lowest-paid laborers would not necessarily exist. The private ownership of natural resources would seem to me to be the most danger-

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*From a paper presented before the Philadelphia Lehigh Club.

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ous application of politics, and it is only necessary to consider this matter carefully to see the fallacy of it.

Then, again, politicians frequently teach that it is bad policy to produce the most wealth for the least labor, on the ground that labor must thereby be thrown out of employment. It is such fallacies as these that technical education should concern itself to eradicate. Then we have the immensely important problem of the distribution of wealth, a thorough general understanding of which would revolutionize business, and it is the ignorance of the masses on this subject that makes it possible for one man to accumulate a billion dollars by diverting to his own possession the product of thousands of laborers.

What is the use of labor-saving machinery or of the immense strides in material progress and scientific management, when the final outcome is to enrich a few, who control the natural resources, at the expense of those who labor?

In my experience I have had in my employ at least fifty technically trained men, of whom probably two-thirds were college graduates. I have also had charge for several years of a manufacturing establishment which required the services of several technically trained men and therefore have had some opportunity to study the value of technical education and to determine those qualities which are of the greatest value to an engineer.

Strangely enough, my conclusion is that the sterling qualities which make the engineer invaluable have nothing whatever to do with technical studies. In the first place, a man must be what is vulgarly known as a "live wire," and have an excess of the qualities known as persistence and reliability, so that when sent to perform a task he does not encounter a "no thoroughfare," but delivers the "Message to Garcia."

I have sometimes thought that the college course should not be practical in the ordinary sense of the word. Engineers should be taught fundamental principles, and be equipped with the tools of science. When they graduate they immediately go into practical work and obtain their practical education, and no matter how much practical training they receive at college, they are not trusted to handle practical problems upon their own responsibility. A thorough knowledge of fundamental principles enables them to obtain their practical training in a much more effective manner and in a shorter time. If I were going to specify a civil-engineering course it would be about as follows:

ENTRANCE EXAMINATION—English grammar, arithmetic, elementary and advanced algebra, plane and solid geometry, physical geography, elementary physics, double-entry bookkeeping, including the ability to write the various forms of drafts, notes, checks, etc.

FRESHMAN YEAR

English, including rhetoric, essays and orations.
Free-hand drawing.
Descriptive geometry.
Elementary chemistry, physics and elementary mechanics.
The use of the slide rule for all calculation where three significant figures are sufficient.
Analytical geometry and calculus.
Plane trigonometry.

SOPHOMORE YEAR

English, including composition, essays and original orations.
Stereotomy.
Chemistry, including chemical combinations and equations.
Analytical geometry, calculus, physics and mechanics, with practical problems in these subjects.
Mechanical drawing.
Surveying.
Elementary astronomy, including the nebular hypothesis.
Short course in meteorology, including evaporation from water surfaces, and the use of weather instruments, such as the barometer and wet- and dry-bulb thermometer.

JUNIOR YEAR

Practical problems in the application of analytical geometry and calculus, including least squares and the formation of equations from observed data.
Analytical mechanics.
Machines, including steam engines, pumps, boilers, air compressors, gas engines, electrical dynamos and motors.
Chemistry, including volumetric analysis of water, determination of total solids, and laboratory practice in assaying.
Mechanics of materials, including principles of reinforced concrete.
Roofs and bridges, including graphical statics.
Surveying.
Mechanical drawing.
English, consisting of debates once per week where each man must talk.

SENIOR YEAR

Principles of political economy.
English, consisting of the practice of writing reports and contracts.
Geology.
Crystallography, mineralogy and lithology.
Water-supply and hydraulic engineering.
Sanitary engineering.
Surveying, including practical use of the sextant for determining latitude and longitude, use of the solar attachment for determining the meridian, practice of quick methods of making traverses and topographical surveys, including the use of the range finder and clinometer for that purpose, practice with aneroid barometer.
Thesis.

You will note from the above that in my outline considerable attention would be given to English. An engineer, if he amounts to anything, must frequently write reports and address bodies of men on engineering subjects or in the presentation of propositions, and it is a valuable accomplishment to be able to express himself on his feet in a manner satisfactory to himself.

It will be seen that only essential subjects are given not only in the course, but in the entrance examinations. If the student wishes to take some other subjects such as French, German, Latin, English literature, general history, sociology or the laws of business, etc., they can be taken as elective courses and not at all as an essential to the study of civil engineering.

While I have had considerable training in the study of foreign languages, including French and Spanish, I have learned more of these languages by the study of grammar coincident with practice among French and Spanish speaking people than I could have learned in the usual course at college. But in all my experience I have never had occasion to study or read an engineering paper or publication in a foreign language.

There is a certain glamour in the minds of many young people over the study of French and German, but if they could only realize how worthless are the actual results they obtain in the college course, they would take a different view; and as for Latin and Greek, I would not give them a moment's thought. All these subjects such as Latin, Greek, literature, ancient and modern history and mythology add a certain amount of polish or veneering to one's training, but they are of too little importance compared with the sciences and should not be embodied in a technical course.

A young man who has had a good common-school education up to the end of his 14th year would add greatly to his future college education if he spent the remainder of his time, up to say the end of his 18th or 19th year, in practical work, as for instance: One year with a bridge-construction gang; another year with a general contractor in railroad or municipal construction; the third year as a rodman or chainman with a survey party, and the fourth year in a general machine shop. It does not make much difference in what capacity he works so long as he is able to get a general practical experience in these lines of work. It will also enable him to study the human-nature problem, which is of great value. At the end of the 19th year, with his previous education, he can readily prepare himself for the entrance requirements as above outlined, so as to enter college at the age of 20. If he amounts to anything he will probably have earned considerable wages during his four years of practical work.

As to the "Thesis," it is generally of little value except as an exercise in English descriptive writing from observation. There are, however, a vast number of things the student could do that would be of real value to society, a few simple examples of which may be: Determination of the coefficient of expansion of some material such as glass, hard rubber; determination of the tensile strength, coefficient of elasticity and relative resistance to bending of the various wires

used in the arts; determination of the rate of evaporation from water surfaces at various temperatures below boiling; the coefficient of discharge through small orifices under varying heads; determination of the loss of head through small service pipes. This list can be multiplied indefinitely.

The point of my paper to which I wish to call particular attention is that in technical education, veneering should be avoided. Fundamentally useful subjects should be selected in only a sufficient number so that the student can be thoroughly grounded in their principles by solving enough original problems to obtain a working knowledge.

Sanitary Control of Oyster and Clam Beds by the State Board of Health of New Jersey was authorized by an Act passed by the Legislature of that state in 1911, as a supplement to the Foods and Drugs Act, Revision of 1907. Under this supplementary legislation the State Board of Health is authorized to inspect or cause the inspection of the oyster and clam beds of the state. If the Board finds that any oyster or clam beds, or any other places in which oysters, clams or other shell fish are, or may be, taken for use as food, are subject to pollution the Board shall then condemn such oyster or clam bed or other place, and prohibit the taking of oysters, clams or other shell fish from such places for distribution for sale as food. Penalties are provided for violations of the law and also means for obtaining injunctions to restrain such violations.

Letters to the Editor

Surveys for a Cross-State Highway in Tennessee

Sir—Apropos of the recent discussions in your columns regarding the Office of Public Roads, Department of Agriculture, and its offer in connection with bridge construction, it may not be amiss to call your attention to a recent article published in a Memphis, Tenn., newspaper. This article stated that the Office of Public Roads would carry on the surveys in connection with the proposed Memphis to Bristol highway.

Memphis and Bristol are at opposite ends of Tennessee, and the proposed highway will be approximately 450 miles long. It would be interesting to have the Office of Public Roads explain this extensive work in connection with one highway, and show how the undertaking can be classed as merely sufficient for educational and experimental purposes.

ROBERT W. GAY,
Professor of Civil Engineering.
Agricultural College, Miss., Mar. 2, 1912.

Mule Haulage in the Kingwood Tunnel

Sir—I have read with interest the article on the Kingwood tunnel (B. & O. R.R.) in your issue of Feb. 22, but an interesting detail which is not mentioned is the handling of mortar for the brick lining. This has been done entirely by a mule ("Queen of Sheba"), who has faithfully performed her duties under many very trying circumstances. Upon her depended the success or failure of the supply of "mud" to the bricklayers, laying brick against time. One peculiar feature of this mule was her partiality for any form of eatables left over from lunch baskets, and these were all gathered in if not placed beyond her reach. The "Queen of Sheba" evidently belonged to some kind of secret labor union (mule), as after the delivery of so many loads of mortar she refused to budge until fed. It seems right that some attention should be given to her services on this important work.

G. H.
Tunnelton, W. Va., Feb. 22, 1912.

The Effect of Cold Weather on Water Consumption in the Boston Metropolitan District

Sir—It may interest some of your readers who are concerned with water-supply questions to see figures illustrating the effect of cold weather upon the consumption of water in the Boston Metropolitan District.

The daily average use during four weeks in December, 1911, as compared with the use during four weeks in the following month of January, with the average temperatures for the several weeks, are given in the following table:

AVERAGE DAILY WATER CONSUMPTION PER WEEK, BOSTON METROPOLITAN DISTRICT, DECEMBER, 1911, AND JANUARY, 1912

(Population 1,056,670)

Week ending	Temperature*	Consumption	Date	Temperature	Consumption
Dec. 9	34.1°	102.744	Jan. 13.	10.8°	138.674
Dec. 16	46.1°	102.322	Jan. 20.	24.4°	143.685
Dec. 23	34.1°	104.420	Jan. 27.	21.3°	134.176
Dec. 30	33.7°	103.192	Feb. 3.	19.4°	143.006
Average		103.169			139.885

*Average for week in degrees F.
†Average million gallons per day for week and month.

The only difference in conditions from December to January was a drop in temperature resulting in an increase in the consumption of 36,716,000 gal. or 36%, in a district where 45.49% of the service pipes are now metered. It is evident that while the use of water meters may curtail the waste of water they will not entirely prevent it.

DEXTER BRACKETT, Chief Engineer,
Metropolitan Water-Works.
Boston, Mass., Feb. 29, 1912.

An Indefinite Law Regarding Bridge Loadings

Sir—The legislature of this state at the last session, passed the following bill:

HOUSE ROLL No. 661

An act to provide for the construction and repair of bridges and culverts.

Be it enacted by the legislature of the State of Nebraska:

Section 1 (Bridges, Culverts, Floors). It is hereby made the duty of the county boards or other officials having charge of the highways in the various counties whenever any bridge or culvert is constructed, reconstructed or overhauled, to use in floors of the same planking not less than 3 in. in thickness, when wood is employed, and to so construct and repair the same, whatever material is employed, that it will sustain a load of not less than 20 tons. Provided, that all culverts shall be so constructed that the floors of the same shall not extend above the level of the adjacent road and all bridges shall be built on straight lines with the direction of the adjacent roads wherever possible. Provided, further, that in counties under township organization town boards shall repair, construct or reconstruct bridges and culverts in accordance with this act.

Approved April 10, 1911.

The loading seems to have been left somewhat indefinite. It seems an engineer might take the load of 20 tons to mean a uniform distributed load as a herd of cattle over the whole bridge, a concentrated load as a road roller, or as a traction engine where the front and hind wheels are about 11 ft. 6 in. centers and 8 ft. gage, two-thirds of the load to be carried on the rear axles.

I would like the opinion of engineers as to what this law should be assumed to mean in regard to loading.

F. A. ROLAND.
Bethany, Neb., Feb. 28, 1912.

A Member of Congress on the Dismissal of Messrs. Elliott and Morehouse

Sir—A friend has handed to me a copy of ENGINEERING NEWS of Feb. 22, and called my attention to your editorial entitled, "Does the Punishment Fit the Crime?" In this editorial you discuss the dismissal from the U. S. Department of Agriculture of Messrs. C. G. Elliott, Chief of the Bureau of Drainage Investigations of that Department, and A. D. Morehouse, his assistant. You state the charges against these officers as set forth by the Solicitor of the Department, and then you proceed to state the real facts as they have been brought to your attention, which latter statement I think is substantially correct. You then express the opinion that the charge was trivial in that it involved a mere irregularity, and in which there was no intent to defraud or to seek personal gain. You also draw the inference that an injustice has been done these officials, and you use this language:

> Is there any way in which the organizations that engineers have formed for mutual benefit can be made use of for mutual defense? If the engineering societies can act to expel a member who has proven dishonorable and unworthy, why can they not also act to defend their member whose reputation is unjustly attacked?"

For the reasons which I will briefly state, I have been impressed by your editorial, and I am constrained to ask the privilege of submitting this communication. For a number of years I have been a Representative in Congress from the First District of North Carolina. This district comprises a number of counties in the eastern or coastal-plain section where the lands are level and have only a slight elevation above tidewater. In this section there are large areas of swamp lands, and much of the reclaimed lands also, require more efficient drainage. For the past five or six years our landowners have become actively interested in the problem of drainage, and we have had occasion many times to avail ourselves of the services of Mr. Elliott and his engineers in the Office of Drainage Investigations.

These conditions brought me frequently in contact with Mr. Elliott and Mr. Morehouse. I think I came to know them well and I believe them both to be honorable men and efficient officials. I have never had any occasion to inquire as to the engineering qualifications of Mr. Morehouse, but information from many sources has convinced me that Mr. Elliott is a distinguished drainage engineer.

Now I wish to emphasize the suggestion contained in your editorial. If Messrs. Elliott and Morehouse had been employed as engineers by a large industrial corporation, I cannot believe that such corporation would have discharged and attempted to humiliate them upon any such grounds, nor do I believe that the executive officers of such corporation would hesitate to reinstate them if such an injustice had been inadvertently perpetrated. I have understood that Mr. Elliott was a member in good standing of the American Society of Civil Engineers. I agree with you that this Society owes a duty to its membership to defend Mr. Elliott and protect his good name from an assault which I believe to be unjustifiable and indefensible.

I have no interest in this matter other than to contribute in this humble way toward emphasizing your suggestion, and in helping to rectify, in so far as I can, what I conceive to be an injury to the reputation of good men.

JNO. H. SMALL.

House of Representatives,
Washington, D. C., Mar. 5, 1912.

More Engineering Poetry

Sir—When I saw, in your issue of Jan. 25, Mr. Stauffer's picture of the intelligent rodman holding his rod so steady and so plumb, I felt like the man who awoke in the morning and found himself famous. Who would not have thrills all up and down his spinal column at finding someone asking for the republication of his Op 9 (or thereabouts) after 28 years of neglect and a cold, indifferent world?

And now I am filled with a thirst for more fame. Another poem, ground out of the same sausage machine at about the same time, found favor in your eyes and space in your columns. It was called "Recrimination"—a lordly title. I have no copy of it, and, as I want to carve it on my tombstone and go thundering down the ages hand in hand with Ella Wheeler Wilcox and the Sweet Singer of Michigan, will you not do me the favor to reprint it?—and I will promise to shut up for another 28 years.

I will do even better than that. If Mr. Stauffer will get out his pencil and make a picture for this poem, too, I will make it, instead of 28 years, permanently.

JOHN H. K. BURGWIN.

Pittsburg, Penn., Feb. 3, 1912.

[Below we reprint with pleasure the poem mentioned by Mr. Burgwin. It was printed in ENGINEERING NEWS of May 3, 1884, p. 216, and was taken (like the previous one) from the S. P. R.R. (South Pennsylvania R.R.) *Transit*. The accompanying illustration appeared at that time and *is* from the pen of Mr. Stauffer, so we are happy to fulfill all the conditions of Mr. Burgwin's request. But we do not ask Mr. Burgwin to fulfill his part of the bargain, for we believe he is not getting more than his due to be credited now, 28 years late, with poems of which the authorship was hitherto unknown. So we shall be pleased to hear from Mr. Burgwin at this or any future time.—ED.]

RECRIMINATION.

The Level.

Says the Level to the Transit:
"Don't you think that you can prance it
Over mountain, field and valley
With your chain and painted flag?
Don't you think you go a jumpin'?
That you keep me just a humpin'
With my plus and minus countin',
You condemned old brag!"

The Transit

Says the Transit to the Level:
"You may go unto the D——L!
You're no good at all for running
Over hill and valley broad.
I can leave you, by the hokey,
You old everlasting pokey,
With your hundredths and your thousandths
And your twelve-foot rod."

The Level.

"Now you'd better just believe me,
You can never never leave me,
For I'll hang on to your coat tails
Like your sweetheart's father's dog.
You kick up an awful rumpus
With your plumb-bob and your compass--
You three-legged pile of scrap-iron,
You old two-toothed cog!"

The Transit

"Draw it milder on your blowing!
You had better quit your crowing
Till we get the other side of
Laurel Hill and Horner's Run.
May I never set a plug
If I don't give you such a tug
As will make your glasses rattle
Like a flint-lock gun."

Notes and Queries

T. A. C. writes: "Who was the inventor of the automatic grab bucket or who is generally reputed to be?"

Speaking from general information only we would say that the earliest automatic grab bucket is doubtless the clam-shell dredge. The late C. W. Hunt, so far as we know, was the first to design a bucket of this general type adapted to the handling of coal. Years after the Hunt "automatic shovel" came into extensive use, it was further modified to enable it to handle such hard and heavy material as lump iron ore.

Issued Weekly by
The Engineering News Publishing Company.
JOHN A. HILL, Pres. CHARLES WHITING BAKER, Sec'y.
ALFRED E. KORNFELD, Vice-Pres. W. W. MAYER, Treas.
GEORGE H. FROST, Chairman Board of Directors.
505 Pearl St., New York.
1138 Monadnock Block, Chicago.
Home Life Building, Washington, D. C.
Z. P. Maruya & Co., Ltd., Tokyo, Japan.

CHARLES WHITING BAKER, M. N. BAKER,
E. E. R. TRATMAN, F. E. SCHMITT,
Editors.

Subscriptions payable in advance, $5.00 a year for 52 numbers, including postage in the United States, Mexico, Cuba, Porto Rico, Hawaii, or the Philippines, $7.00 in Canada.

To foreign countries, including postage, $9.00 or its equivalent, 36 shillings: 36 marks: or 45 francs.

Notice to discontinue should be written to the New York Office in every instance.

Advertising copy should reach New York Office by Thursday of week before date of issue.

Entered at New York Postoffice as mail matter of the second class.

CIRCULATION STATEMENT

During 1911 we printed a total of 931,958 copies.

Of this issue, 19,000.

None sent free regularly, no returns from news companies, no back numbers kept beyond current year.

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Engineering News

Sewage Pumps and the Layout of Sewerage Systems

Elsewhere in this issue there is described a novel centrifugal pump invented by Hon. R. C. Parsons, well known as the English inventor of steam turbines. This pump has been designed by Mr. Parsons for the express purpose of handling unscreened sewage and eliminating the possibility of any clogging of the pump occurring from solid matter in the sewage. Mr. Parsons' scheme is an ingenious one and entirely novel so far as we are aware, and deserves the careful attention of engineers engaged in the design of sewerage systems.

Every engineer engaged in this sort of work endeavors to avoid, so far as possible, the pumping of sewage; but to secure grades steep enough to make the sewers self-cleaning is often very difficult in a city built on a flat plain. Difficulty is also often encountered in cities where the topography includes several natural drainage stations, to secure the final discharge of all the sewage at one central point. This is often necessary where some form of treatment must be given the crude sewage before discharge.

The use of ejectors operated by compressed air to raise sewage from low points in the system to higher elevations has long been familiar to engineers; but such machines are quite inefficient as pumps. Their capacity is comparatively limited, and the laying of pipe for distributing compressed air to a number of such ejectors, scattered over a wide area, is an item of considerable expense.

Mr. Parsons, therefore, set himself the task of adapting the ordinary centrifugal pump, direct-connected to an electric motor, to the work of pumping unscreened sewage. His "Stereophagus," which "eats them whole," is a centrifugal pump which, according to reports of tests made upon it, kept steadily running without a flicker while such materials as dead cats, blocks of hard wood and old overalls were fed to it.

The value of such a machine for use where sewage must be pumped will be obvious to every designer of sewerage systems. On the other hand, engineers will have to be fully convinced of the reliability of such apparatus before undertaking to increase the number of pumping stations in a sewerage system. Apart from the pump itself, the supply of electric current to drive the motor which operates the pump must be absolutely certain. The stoppage of a sewage-pumping station for even a few hours may cause flooding of sewers over a considerable territory, with resultant damage to property.

One does not have to assume an increase in the number of pumping stations in a sewerage layout, however, to establish the importance of Mr. Parson's invention. With the extension of sewage-treatment processes, there are more and more places all the time where sewage pumping is essential, and a centrifugal pump which is proof against clogging, even when pumping unscreened sewage, is a boon to the sewerage engineer.

The Institution of Civil Engineers Establishes an "Appointments Board"

As many of our readers will recall, in our issue of Aug. 17 last, we urged that the best thing the engineering profession could do to improve its position would be to have the principal engineering societies organize bureaus which should put those desiring to employ engineers in touch with men competent to perform each class of work. A number of the local engineering societies in this country are already doing something in this line, as is also the American Society of Mechanical Engineers.

From our English exchanges we learn that the oldest and most conservative engineering society in the world, the Institution of Civil Engineers of Great Britain, has just created an Appointments Board. A circular issued by the Institution announces that this Board will receive applications for engineering employment and also applications from employers for engineering assistance, and will endeavor to further the interests of both parties by placing them in communication. The members of the Board are Sir Alexander Binnie, Lord Cowdray, Sir Alexander B. W. Kennedy and Dr. J. H. Tudsbery, Secretary of the Institution. From the wording of the circular it appears that the Board intends to deal at present only with minor positions in engineering work.

The establishment of this Board by so great and so conservative an engineering society as the Institution of Civil Engineers is a departure of great interest. There can be little doubt that from this beginning the work will eventually be extended to include the recommendation of men for high positions in the profession for membership on public bodies and for consulting engineering work. There is good precedent for this in the action of

the Bar Associations in aiding in the selection of candidates for Judges.

That the older engineers, as well as the younger, often need the aid that might be given by such a bureau is illustrated by a brief comment in the London *Times* Engineering Supplement:

> Although the benefit will probably be most largely enjoyed by junior men, it must not be forgotten that there is a duty to perform to senior men who, after the completion of foreign service, often lose touch with headquarters and with those at home who know where new employment may be sought.

Who Should Pay for Building and Maintaining Good Roads?

Governor Foss, of Massachusetts, recently sent a special message to the Legislature urging that in view of the increased cost of highway construction and maintenance, due to the extensive use of automobiles, the fees for automobile licenses should be increased to an average of about $1 per hp. The present automobile license fees in Massachusetts are said to average about 38c. per hp.

Accompanying the message was a statement by Col. W. D. Sohier, Chairman of the Massachusetts Highway Commission, in which it is stated that the necessity of using bituminous binder in road construction on account of automobile wear has increased the first cost of road construction from 20 to 50%. Over $300,000 was spent last year by the Massachusetts Highway Commission in treating with oil or tar the roads used by through automobile travel. This was necessary not only on account of the dust nuisance along the route, but to prevent the roads being destroyed by the rapid moving vehicles. Up to the advent of the automobile, Massachusetts spent not over $100,000 a year to maintain its state highway system. In the last three years it has had to spend substantially $500,000 per annum for the same purpose. The rapid increase in the number of automobiles and consequent road wear is shown by the fact that while the number of automobiles registered in Massachusetts in 1909 was under 24,000, in 1911 it was nearly 39,000. The rapid increase in motor trucks also presents new problems in road maintenance. Lines of motor trucks are beginning to deliver goods from Boston to other cities within a radius of 30 to 40 miles. The present tax on these vehicles used for commercial purposes is only $5, no matter how heavy and how high powered they may be.

Under these circumstances, Governor Foss's recommendation that the tax on automobiles should be raised to approximately $1 per hp. per annum is the most promising plan we have anywhere seen for providing funds for road maintenance. Governor Foss couples with this proposal a recommendation that the state appropriate $5,000,000 to be expended during the next five years in building new state highways. Certainly if the taxpayers furnish the money to build the roads, those who run automobiles over the roads and wear them out should pay for the destruction they cause.

An interesting suggestion which is made by Colonel Sohier is that the increased tax on automobiles might actually be beneficial to automobile owners by reason of the better maintenance of roads thus made possible. He estimates on the basis of the average annual mileage made by automobiles that the proposed registration fee of $1 per hp. would amount to only 0.1 to 0.4 of a cent per car mile, or hardly one-eighth of the expense of the car owner to maintain the tires. A very slight increase in the mileage of tires due to better maintained roads, therefore, would fully offset the increased amount paid by the car owner for his license.

It seems to us that this Massachusetts proposal is worth general attention. All over the country agitation is going on for good-road construction. States, counties and cities are making appropriations for road construction on a scale that would have been considered impossible ten or even five years ago; but while millions are being raised for good road construction little attention is being paid to the question of how these good roads are to be maintained when once they are built. In fact, one of the stock arguments of the agitators for good roads construction is that the taxpayers will save money because it will cost less per mile to maintain paved roads than is now spent in maintaining dirt roads.

A good illustration of this is a pamphlet before us, recently issued by the Universal Portland Cement Co., which declares that "our present annual expenditure on roads is $79,771,417.87," and then, on the basis of these admirably accurate figures, proceeds to compute the saving at the end of 30 years if 20% of the road mileage, or 400,000 miles, were "rendered permanent" at a total cost of $3,600,000,000." In this computation, no allowance whatever is made for the maintenance of these 400,000 miles of "permanent roads" during the 30 years, and it is assumed that the entire amount now expended on road maintenance would be saved. It may be remarked that if the figures given above are correct, they show an average annual expenditure for the whole United States on its present road system of only $40 per mile of road, and this includes not maintenance alone, but bridge and culvert work as well as new construction.

We regret to say that this sort of wild exaggeration and absurd computation is not exceptional, but typical of the "uplift literature" circulated in support of the good-roads movement. The public is being buncoed into the belief that good roads once built will cost less to maintain than dirt roads and will be so "permanent" that it is justifiable to transfer the burden of paying for them to a future generation.

To most of our readers it is, of course, almost needless to say that a "good road" costs far more to maintain than a dirt road and that if it is not properly maintained, it soon becomes worse to travel over at most seasons than the dirt road which it replaced. Engineers know well that there is no such thing as a "permanent" road or "permanent" paving. That ancient fallacy was responsible for the practice formerly common of requiring paving contractors to furnish a bond for maintenance for a term of years, a practice which has cost the taxpayers of American cities a good many millions of dollars.

But some of our readers may say: "Why does ENGINEERING NEWS go out of its way to criticize the good roads agitators? The more good roads built, the more work for engineers and the larger the market for road materials and supplies."

That is one way of looking at it; but it is, in our opinion, a very short-sighted way. The fact that the public is going to lay the blame on the engineer when it finds how soon the "good roads" wear out and what it costs to maintain them, alone justifies our criticism. Why should the public not blame the engineer? It has read in the public press and in documents issued under authority of federal and state governments that "good roads" once built are "permanent." It has no suspicion that perhaps a tenth part of what a good road costs to build must be spent annually on its maintenance. Hence, when the public finds its newly built good roads rapidly going to pieces and huge demands for money to maintain them, it naturally concludes that the engineer who built the roads didn't know his business.

For the protection of the engineering profession, as well as for the protection of the taxpayers from unwise schemes for good-road construction, therefore, the fallacies of the good-roads agitators ought to be exposed and condemned.

Another common fallacy of good-roads promoters is that the expense of building good roads may be paid for from assessments laid upon the owners of abutting property. This is justified by various examples of lands in city suburbs which have been transformed from farm property into building lots—not merely by the building of a good road, as the promoter claims, but by the growth of the city.

It is well recognized, of course, that a property owner may be fairly assessed for permanent improvements in his street, such as sewers, sidewalks, gutters, and such a paving as will make the street convenient for his use. Such improvements are benefits increasing the value of the property.

But there is no justice in assessing on a property owner the cost of laying in front of his land an especially expensive pavement suitable for automobile traffic. The passage of a hundred or a thousand automobiles in front of his place daily is a nuisance to him rather than a benefit, a nuisance which often depreciates the value of his property. To compel him to pay for the "good road" which brings this nuisance is adding insult to injury.

If it is unjust to assess him for the first cost, much more is it unjust to assess him for maintaining the roadway. Why should he have to pay for the wear and tear done by these rapid moving machines to the road surface? It would be as just to compel the owner of land alongside a railroad track to pay for maintaining the ties and rails.

That the burden of paying for good-roads construction ought neither to fall on the land owner nor on the locality, when the road is of general rather than local use is now recognized in the numerous states which are building good roads with state funds. The little town of Becket in Massachusetts has a total assessed valuation of only $500,000. The state has spent $100,000 in the town on a through road between Springfield and Pittsfield and will have to expend more for maintaining this road every year than the entire amount raised by Becket for all the roads in the town.

Perhaps the worst feature in connection with the good-roads agitation is that almost all the good-road construction by states and counties is being done on borrowed money due so many years hence that many of the roads built with the money will be worn out before some of the taxpayers who will have to pay the bonds at maturity are born. New York's fifty million dollars of good-roads bonds run for 50 years. The Province of Quebec is considering a good-roads law in which the bonds for the work are to run for 41 years. Fortunately some other states are proceeding in more conservative fashion. Indiana's county bonds for road construction, for example, are limited by statute to 20 years, or an average life of 10 years.

The City Club of New York has just sent a protest to the Board of Aldermen against the issue of 50-year bonds by New York City to pay for street paving. It urges that bonds for such work should run no longer than the average life of street paving in New York City, which in the past has been about 10 years. What is true of New York's street pavements is true of good roads in the country districts subjected to present-day automobile traffic. It is as unjust to transfer to the next generation the burden of paying for pavements which will be worn out in a few years as it would be for a man to borrow money for a suit of clothes, giving in payment a note to be paid by his son a quarter of a century hence.

It is a sound principle to lay down that the cost of constructing good roads should be met by the localities whose residents are to use them. Cities and towns should pay for the streets and local roads which are chiefly for local traffic, and the state should bear the cost of roads which are burdened with through traffic. The best and safest way to pay for such roads is to raise the money by direct taxation; but if a bond issue cannot be avoided, the bonds should be protected by a sinking-fund provision to secure the final payment of the whole issue in not longer than 10 to 15 years.

And if the cost of building good roads is borne by the taxpayers, then the automobile interests which are so active at present in furthering enormous expenditure by states, cities and counties in this field should assent to the proposition that the burden of maintaining these roads should be borne by those who cause the wear and tear.

We heartily approve Governor Foss' suggestion that fees for automobile licenses should be raised to a point where they will provide sufficient revenue to take care of road-maintenance expenses.

In framing an automobile-license law, however, it can easily be provided that the burden of taxation shall fall most heavily on the machines that do the most damage. The tax law of Great Britain on motor vehicles, which was put in force two years ago, imposes a very much heavier tax on the heavy, high-powered machines than on the smaller and lighter machines. It is the high-speed heavy cars which do the chief damage to the road's surface. We print below the English rate of taxation on motor cars,* but it should be explained that besides the annual license fees there given, an excise tax on gasoline for automobile use yields as much revenue as the automobile licenses. All the revenue thus obtained is devoted to road construction and maintenance.

In addition to this, as we have heretofore pointed out in these columns, the English law fixes a limit to the weight which may be carried upon a motor vehicle per inch of tire width and also the maximum speed at which heavy motor trucks may be run.

There can be no quarrel with the justice of these restrictions, nor with the justice of the taxation imposed. The increasing burden of taxation levied by cities, counties and states is reaching in many places the limit which property can stand. In New York City, for example, a special commission appointed by the Mayor to find new sources from which the city can raise the revenue required for its increasing necessities advises that special taxes be placed on hotels, restaurants, theaters, department stores, automobile salesrooms and art stores.

We earnestly urge, therefore, that in every state where the automobile interests are agitating for large expenditures for good-roads construction, a counter agitation be started to place upon the automobile owners the burden of roadway maintenance. If necessary, the tax might be extended to all wheeled vehicles in proportion to the damage done to the roads by vehicles of different classes. Enough is now known concerning this damage to enable such an apportionment to be made with reasonable accuracy.

*Annual license fees for motor cars in England: Motor bicycles and motor tricycles, $5; motor cars not over 6½ hp., $10.50; motor cars over 6½ but not over 12 hp., $15.75; over 12 but not over 16 hp., $21; over 16 but not over 26 hp., $31.50; over 26 but not over 33 hp., $42; over 33 but not over 40 hp., $52.50; over 40, but not over 60 hp., $105; over 60 hp., $210.

The Life of Steel Rails*

A very distorted impression obtains in many quarters as to the average life of a steel rail. Over a limited mileage, rails do wear out in a few years, but on an average they last a very long time. For strictly replacement purposes, the railroads have hardly yet reached an annual consumption of 1,000,000 tons a year, yet they have 360,000 miles of track.

What is needed is a wide range of rail quality, at varying prices. All the rails should be made safe, which can be done by sacrificing a portion of the extreme of durability which has lately been sought by the unsafe method of increasing the carbon without heat treatment or other palliative. Then those which are subjected to heavy duty should be improved in wearing quality by methods which rail makers can readily develop, when the railroad engineers place themselves in position to know how much they can afford to pay, in price per yard of rail.

It is probable that the chemical specification is of much less account than the physical structure—the rail must be made physically sound, free from slag inclosures, etc. The great success of titanium treatment points in this direction as the titanium acts chiefly as a purifier and only in special cases as an alloying element.

The success of electric-furnace treatment would also rest to a large extent on an analogous basis; since the refining of the steel in a non-oxidizing atmosphere in the electric furnace would permit thorough removal of all gases, slag particles, etc. In this respect the results obtained this winter on northwestern lines with 5000 tons of electric steel rails (made from steel refined in the Heroult furnace) are significant, as there was not a single breakage of these rails, while there were some 200 breaks of bessemer and open-hearth rails of the same weight and under the same kind of service on these lines.

*Excerpt from an editorial in the "Metallurgical and Chemical Engineer."

Further Notes on the Spang-Chalfant Concrete Building Failure

On this and the following page we present some additional views of the collapsed portion and details of the construction of the Spang-Chalfant reinforced-concrete building, whose failure we recorded in our issue of Feb. 29, 1912, p. 415.

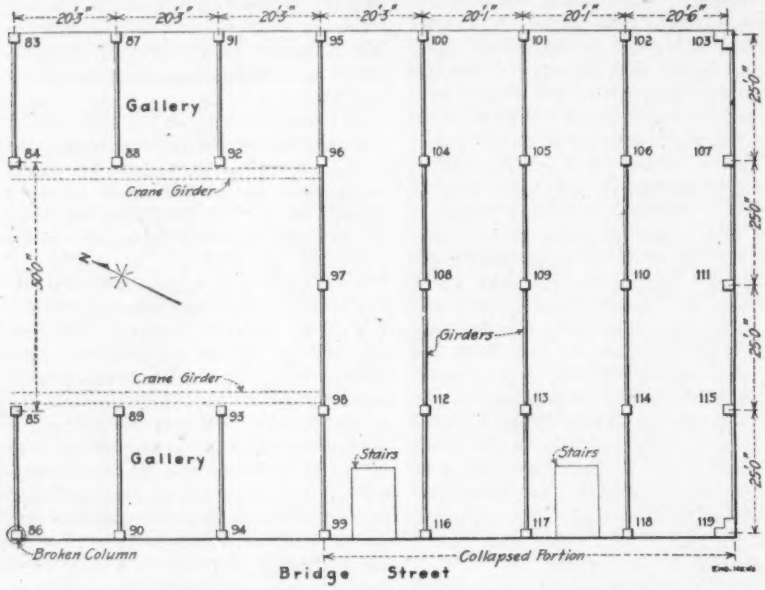


FIG. 1. PLAN OF THE COLLAPSED PORTION OF THE SPANG-CHALFANT BUILDING

Fig. 1 shows the plan of the collapsed portion, together with the adjacent shop building which was not affected, except for the damage done to the old and seasoned column 86 as noted by Mr. Godfrey in our previous report. This column, it will be seen, was fully 60 ft. away from the nearest limit of the zone of the failure, but in spite of this it was most seriously affected by the shock of the collapse. Column 114, which was typical of all of the columns in the collapsed portion was 12x12 in. for the top story, 14x14 in. for the third story and 18x18 in. for the lower two stories. Fig. 3 shows the height of these stories and an outline diagram of the column and girder layout.

Fig. 4 gives the details of the girder and floor-slab design. Regarding this design, Edward Godfrey, who forwarded to us the drawings from which the cuts were made, says:

> The floor slabs are evidently designed to act as a combination of cantilever and slab. It can be seen that with a balanced load, the portion across a beam could act as a cantilever. It is not evident how any such action could take place in the case of a portion of the slab resting on a wall, or a wall girder, or a girder where there is an opening on the other side. Rotation of the girder or the upper part of the wall would meet with but slight resistance.

FIG. 2. VIEW OF COLLAPSE, LOOKING TOWARD BRIDGE ST. SIDE OF BUILDING

(Column numbers correspond to those on plan in Fig. 1.)

Fig. 2 is a halftone made from two photographs taken from practically the same standpoint and shows the wreck looking from Bridge St. east. The collapsed columns are numbered the same as on the plan in Fig. 1, so that the general layout may be followed from that drawing and the halftone. It will be noted that the column failure in all cases is practically the same and the rear view of Column 109, given in Fig. 5, is typical of the other columns. The columns were reinforced with four deformed bars, one at each corner, tied together with light wire which had no effect whatever in holding the rods in place.

There is no building department in the Borough of Etna, so there is no official body to investigate the failure, particularly as the absence of any fatality in the accident makes a coroner's inquest impossible. The Commission for the Revision of the Building Laws of Pittsburg has made an investigation, however, and it is expected that this will soon be made public.

Fourth Annual Meeting of the Illinois Water Supply Association

Reported by PAUL HANSEN*

The fourth annual meeting of the Illinois Water Supply Association was held at the University of Illinois, Urbana, Ill., on Mar. 5 and 6. The meeting was the most successful the organization has had, both in point of attendance and the character of the papers presented. Among those present were mayors, city commissioners, consulting engineers, sanitarians and superintendents of privately and publicly owned water-works.

President O. T. Smith's address, which opened the meeting, was happily worded

*Engineer, State Water Survey, Urbana, Ill.

and well voiced the spirit of the association. He pointed out that efforts on the part of water-works men to make public water supplies please the public is good business, and gave point to his remarks by stating that in water-works operation

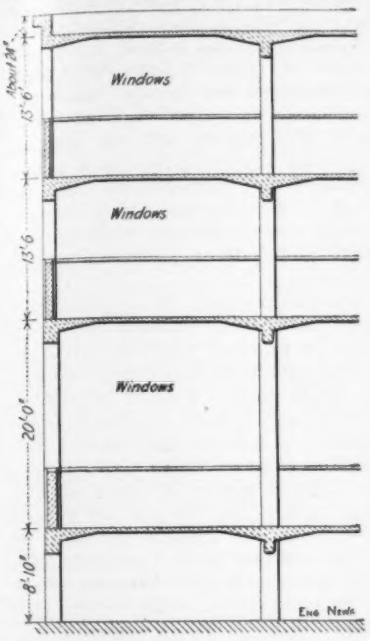


FIG. 3. PARTIAL SECTION B-B (FIG. 1), SHOWING TYPICAL ELEVATION

there is a tendency "to sieze trouble by the forelock and opportunity by the tail."

The report of the Secretary-Treasurer, Prof. Edward Bartow, showed the association to be in sound financial condition and gave a present enrollment of 207 fully paid up members, which represents a very rapid growth since the last meeting.

In a brief talk on pumping by steam and electricity, E. MacDonald, superintendent of the Water & Light Co., of Lincoln, Ill., stated that by uniting the water-works pumping station and the electric-lighting plant, pumping can frequently be accomplished at no additional cost over that involved in the operation of the light plant alone. This statement gave rise to a rather spirited discussion in which it was pointed out that such a condition will not obtain, provided high-class pumping machinery is used and this machinery properly operated, though many advantages in the combination suggested were admitted.

Several interesting papers were presented on the effect of metering public water supplies and there seemed to be a hearty unanimity of opinion in favor of the complete metering of public water supplies. It was also agreed that there should be no free services.

Dow R. Gwinn, of Terre Haute, Ind., presented an interesting paper on a spot-map method of maintaining fire hydrants in good condition. This brought out by way of discussion from Dabney H. Maury a method in use at Peoria, Ill., whereby the fire department is made to coöperate with the water company in locating defective fire hydrants.

W. J. Spaulding, commissioner of Public Property of Springfield, Ill., in a paper on "Water Department Methods," presented a strong argument in favor of extending mains by assessment on benefited property owners rather than by paying for same out of the earnings of the water-works or by general taxation.

Other papers which proved of great interest to water-works managers dealt with "Purchase of Coal in Accordance with Specifications," by W. O. Collins; "Storage of Coal," by S. W. Parr, and "Anchor Ice about Water Works Intakes," by L. C. Trow. In discussing storage of coal it was brought out that a depth of 8 ft. or less for the coal pile will prevent spontaneous combustion.

Several papers on the sterilization of public water supplies with hypochlorite of lime gave rise to a spirited discussion, during which it was brought out that, except in those water-works where there is a long period during which the chemical may react before the water reaches the consumers, tastes and odors are almost certain to arise. Erie, Penn.; Evanston, Ill.; Lake Forest, Ill.; Cleveland and Columbus, Ohio, were mentioned as examples. Wm. G. Clark, consulting engineer, Toledo, Ohio, stated that hypochlorite tastes and odors may be avoided even when using comparatively large quantities, provided care is taken to maintain free carbonic acid in the water. Dr. Arthur Lederer, of the Sanitary District of Chicago, described some laboratory experiments to determine the quantity of hypochlorite and free chlorine necessary to produce a taste in the water. Autosuggestion proved to be a confusing factor, but in general women were found to be more sensitive to the taste than

FIG. 5. VIEW OF COLUMN 109, SHOWING MODE OF FAILURE

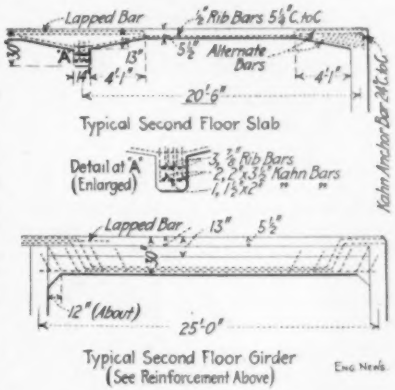


FIG. 4. DETAILS OF SECOND-FLOOR SLABS AND GIRDERS

men; there was no appreciable difference in tastes produced by hypochlorite and chlorine gas, and one-half part per million of available chlorine on Lake Michigan water can generally be detected.

One session was devoted to a discussion of typhoid fever. Dr. A. J. McLaughlin, of the U. S. Public Health and Marine Hospital Service, gave a very clear exposition of the relation between water supplies and typhoid fever. H. N. Parker gave a most practical and helpful paper on how water-works men may study typhoid-fever conditions in a way that will not only protect the water-works against unjust criticism, but which will also point out the real source of danger. A paper by H. W. Hill, M. D., of Minneapolis, emphasized the over importance given to well-water infection, particularly in rural districts, and the lack of importance given to contact infection and infection by flies.

Representative W. P. Holladay, secretary of the legislative committee on public-utilities commissions, outlined the work the committee is doing preliminary to the formulation of a law to be presented before the next legislature for establishing a public-utilities commission in the State of Illinois. Mr. Holladay invited the cooperation of the Illinois Water Supply Association and accordingly a committee of the association was appointed to meet with the legislative committee for the purpose of giving information in connection with water-works matters.

Many other papers of great value to water-works men were read, covering "Incrustations in Water Mains," by F. M. Sinsabaugh and H. P. Corson; "Mechanical Troubles in Pumping Stations," by M. M. Symons; "Color in Mississippi River Water," by W. F. Monfort; "A Sanitary Survey of the Mississippi River at

Moline," by Prof. Edward Bartow; "Experiments on Iron Removal from Drift Well Water," by Prof. A. N. Talbot, and "Water Purification," by W. W. Deberrard. Most of the papers were illustrated by slides.

Annual Convention of the Idaho Society of Engineers

By Ira F. Shaffner*

The third annual convention of the Idaho Society of Engineers was held in Boise, Feb. 22 to 24. On the first day, Governor J. H. Hawley delivered a congratulatory address of welcome, and the retiring president of the society, D. A. Utter, U. S. Surveyor General for Idaho, reviewed the year's work. W. G. Stewart, of the U. S. Reclamation Service, presented a paper on water-measuring devices.

On the second day, at a local theater, th members saw moving pictures of work on the Panama Canal, New York State Barge Canal and the New York City Aqueduct, as well as stereopticon slides of other construction work. Views of the Twin Falls development of the Salmon River Land & Development Co. were explained by Arch Gilbert, assistant engineer of the project; the Magic and Roosevelt Dams, Arrow Rock Damsite and the diversion dam of the Boise-Payette Project were explained by A. E. Robinson, state engineer. Prof. C. N. Little, of the University of Idaho, presented a paper on good roads, and this was followed by the report of C. C. Sharf, of Boise, who had attended the Rochester Good Roads Convention and the Chicago Irrigation Congress, and had visited a number of Eastern cities.

In the evening the members took their annual bath at the Natatorium, to the accompaniment of music and dancing.

On the third day, P. M. Fogg, project engineer of the Reclamation Service at Rupert, discussed the drainage of over-irrigated lands, and related experiences in lowering water level and draining submerged areas on the Minidoka project. W. G. Swendson, of Boise, presented a paper on water-power plants.

The annual banquet was held on this night, and the following day (Sunday) was given up to an excursion to the Arrow Rock Damsite, where the members were entertained by the Reclamation Service engineers.

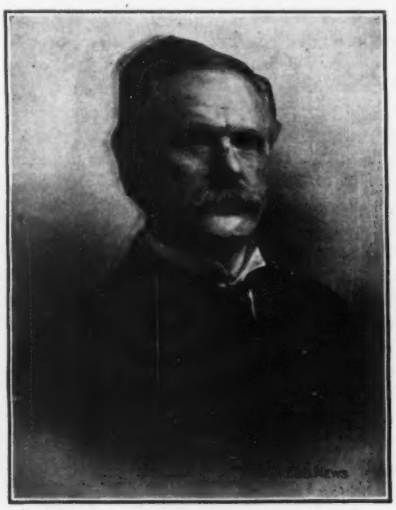
The following officers were elected for the ensuing year: President, D. G. Martin, of Idaho Falls; vice-president, A. E. Robinson, of Boise; treasurer, Edward Hedden, of Caldwell; secretary, Ira F. Shaffner, of Boise.

Next year's convention will be held at Weiser, and it is hoped to take a side trip to the Ox Bow tunnel and power plant in the Snake River Cañon.

*Secretary, Idaho Society of Engineers, P. O. Box 1133, Boise, Idaho.

Milton P. Higgins

The engineering profession has lost a distinguished and useful member in the death, on Mar. 7, of Milton P. Higgins, of Worcester, Mass. Although of late years known chiefly as a successful manufacturer—as President of the Norton Co., the Plunger Elevator Co., the Worcester Pressed Steel Co., of Worcester, and of the Manchester Supply Co., of Manchester, N. H., and of the Sanford Riley Stoker Co., of Providence, R. I.—Mr. Higgins always retained a deep interest in engineering and industrial education. To him belongs the credit of having established the first real manufacturing plant to be used as an adjunct in the education of young men in mechanical engineering.



Milton P. Higgins.

Mr. Higgins was born in Standish, Me., on Dec. 7, 1842, of an old New England family. At 17 years of age he entered the works of the Amoskeag Manufacturing Co., of Manchester, N. H., as an apprentice. Here by economy and hard evening study he prepared himself for Dartmouth College, from which he graduated in 1868 with the degree of Bachelor of Science.

Soon after leaving Dartmouth he went to Worcester, Mass., where he began work as a draftsman with the Washburn & Moen Wire Works, now one of the principal works of the American Steel & Wire Co. It was here that he made the acquaintance of the late C. H. Morgan and other trustees of the Worcester Polytechnic Institute, which was then in its first stage of development.

Mr. Higgins was selected by them to be Superintendent of the Washburn Shops, established by the Institute as a commercial manufacturing plant, employing regular journeymen and existing for the sole purpose of furnishing instruction in practical shopwork and shop management to mechanical-engineering students. For 28 years Mr. Higgins held this position. Under his direction a number of special machines were developed and manufactured at the Institute. Here he first brought out his grinding machinery and the manufacture of hydraulic plunger elevators.

In 1885, realizing the possibility of a small emery-wheel business then struggling for existence under the late F. B. Norton, he and his associate at the Institute, Prof. Geo. I. Alden, took over the business and founded the Norton Emery Wheel Co., and later the Norton Grinding Co., and the Norton Co. In 1889, Mr. Higgins received a year's leave of absence from the Institute and went to Atlanta, Ga., to organize the shops of the Georgia Institute of Technology along lines similar to those at Worcester. Later he also planned the shops of the Miller Manual Labor School of Virginia.

The manufacture of plunger elevators outgrew the Washburn Shops, and in 1896 the business was sold to Mr. Higgins, who, with Prof. Alden, then withdrew from the Institute faculty and organized the Plunger Elevator Co., of which Mr. Higgins was President and Prof. Alden, Treasurer. In 1903, Mr. Higgins was elected a trustee of the Institute and held that office to the time of his death.

Aside from his interest in the Worcester Polytechnic Institute, Mr. Higgins gave much time and thought to technical and more especially to industrial education. He was a member of the Massachusetts State Commission on Industrial Education under Governor Douglas, and it was largely through his active work that the Worcester Trade School was established in 1908.

Mr. Higgins was elected a member of the American Society of Mechanical Engineers in 1880, and was a vice-president in 1901-1902. His paper presented before the Society in 1899 on the "Education of Machinists, Foremen and Mechanical Engineers" has remained a notable work on the subject of industrial education.

Personally, Mr. Higgins was of a genial disposition, democratic, and always interested in young men and their life problems. Many successful mechanical engineers of today owe him much for the inspiration and help which he gave to them when they were students under him at the Washburn Shops of the Worcester Polytechnic Institute.

A Coal Mine Explosion at Merritt, B. C., Mar. 7, in the mine of the Diamond Vale Mining Co., entombed 15 men. Reports state that seven dead bodies have been recovered.

A Broken Rail is assigned in press reports as the cause of the wreck of the Wabash Continental Limited on the Wabash R.R., at West Lebanon, Ind., Mar. 7, in which five persons were killed and some 60 others injured.

A Butting Collision between a passenger train and a light engine on the Atlantic Coast Line Ry., in the yards at Wilmington, N. C., Mar. 8, caused the death of four railway employees. A number of passengers were injured.

The Twentieth Century Limited on the Lake Shore & Michigan Southern Ry. was derailed, Mar. 7, near the Collingwood yard, at Cleveland, Ohio. A switchman's shanty was wrecked and the switchman killed. One passenger was seriously injured. The accident is ascribed in press reports to a broken wheel.

The Forgetting of Train Orders caused a butting collision between a freight and a passenger train, Mar. 8, on the Central of Georgia R.R., near Social Circle, Ga. It was discovered too late to stop either train, that the two trains were speeding toward each other over a single track, and a wrecking train was started for the scene from Augusta before the collision occurred.

Confusion of train orders caused a collision between a freight and a passenger train on the Canadian Pacific Ry., Mar. 8, near Ottawa, Ont. Five persons were killed and eleven injured. The passenger train had run from Waltham, Que., to Hull, and was then reversed in accordance with the usual custom at the Hull station to back into the Union Station at Ottawa. At about the same time the freight train was started over the same track from the Union Station to Hull. The persons killed were in the middle car of the three making up the passenger train. This car was of the second-class and was telescoped by the first-class car at the rear of the train. The railway's official statement puts the blame for the accident upon the telegraph operator at the Hull station.

A New Fast Train from Chicago to San Francisco is announced as one of the changes which is to result from an agreement entered into by the Union Pacific Ry. and Chicago, Milwaukee & St. Paul Ry. The changes are to go into effect about May 15, 1912, when three new trains will be put into service between Chicago and the Coast. One of these trains will be an extra-fare train operated over the Northwestern-Union-Southern Pacific Line, and will cut the time between Chicago and San Francisco four hours under the present reduced time of the Overland Limited. The new running time between Chicago and San Francisco will be 64 hours.

The South Pole Was Reached by Capt. Roald Amundsen, Dec. 14, 1911, according to cable dispatches sent out by him from Hobart, Tasmania, Mar. 7, 1912. In February and March, 1911, the Amundsen party established depots of fuel and food at 80°, 81° and 82° south latitude. The party then retreated to the coast of the Antartic Continent to pass the winter, and in the following spring, that is, in October, 1911, Amundsen with four men, four sledges and 52 dogs started on the trip toward the pole, making use of the food supplies previously established. The entire party of five men reached the pole and remained there three days. The voyage to the Antartic Continent was made in the ship "Fram," which was originally used some years ago by Nansen in an Arctic voyage. Incidentally, the "Fram" is credited with having attained the highest South latitude (78° 41') ever reached by any vessel. According to information supplied by the Busch-Sulzer Bros.-Diesel Engine Co., of St. Louis, Mo., the "Fram" was equipped with a Diesel engine built by the Norwegian licensees. The increased carrying capacity and greater radius of action secured by the use of the Diesel engine in place of steam were found of great advantage.

The Burden of Testing Meters has been adjusted by the Wisconsin Railroad Commission in the case of the electric service of the Superior Water, Light & Power Co., as follows: On lighting circuits, approved recent types of induction meters are to be tested once each 18 months where the annual revenue is $60 or less; where the annual revenue is from $60 to $180 all types are to be tested at least once every 12 months; where the revenue is from $180 to $360 all types are to be tested once each six months and, where the revenue is over $360, once each three months. Induction types of meters on power circuits are to be tested once each six months and commutator types once each three months. Whenever any meter is found to register outside the Commission's requirements it is to be shifted to the next class above so as to be tested more frequently, except in cases where the cause of trouble is not apt to occur again. This order is tentative—subject to recall if found unsatisfactory or unreasonable.

Panama Canal Excavation during February totaled 2,643,410 cu.yd., a daily average of 110,142 cu.yd. for each of the 24 working days. The rainfall for the month was 1.01 in. The amount of concrete laid during February was 113,464 cu.yd. and 418,248 cu.yd. of fill were placed in dams.

The Organization of a National Commercial association is proposed in an invitation sent out by Secretary Nagel, of the Department of Commerce and Labor, accompanied by a letter from President Taft. Invitations have been issued to 1000 commercial and industrial associations in all parts of the United States, inviting them to send delegates to take part in a conference in Washington on Apr. 15 to consider the formation of a national organization representative of the commercial and industrial interests of the entire country. In his letter suggesting the formation of such an organization, President Taft says:

> It appears to me obvious that such an organization must be instrumental in a very large field to aid and assist the executive and legislative branches of government in the intelligent and impartial development of domestic and foreign trade. For illustration, such an organization properly represented at the seat of the government could be of incalculable assistance in advising the executive branch of government with respect to the methods and rules to be adopted in the administration of existing law. It could be of like assistance in giving advice in regard to proposed new legislation and in counseling representatives of the executive branch when asked to submit recommendations upon bills introduced and pending before committees. Such an organization would be in the best possible position to suggest fields for new inquiry at home and abroad, the methods by which such inquiries should be pursued and the means by which the results can be most advantageously brought to the attention of our merchants and manufacturers.

Personals

Mr. F. E. Guy has been appointed Assistant Eastern Traffic Manager of the Universal Portland Cement Co., of Chicago, Ill.

Mr. F. F. Mallon, formerly Chief Engineer of the Colorado Midland Ry., has been made City Engineer of Colorado Springs, Colo.

Mr. S. Percy Hooker, of Leroy, N. Y., formerly Chairman of the New York State Highway Commission, has been appointed State Engineer of New Hampshire.

Mr. B. Shimoda, of the Imperial Government Rys., of Japan, is in this country. It is reported that he has come to place large orders for locomotives and railway material.

Mr. Albert M. Brosius, M. Am. Soc. C. E., First Assistant Engineer of the Baltimore, Md., Sewerage Commission, has resigned to take charge of paving and sewerage work in Havana, Cuba.

Mr. Charles E. Warren, an electrical engineer of Baltimore, Md., has been appointed a member of the Public Utilities Board of that city, succeeding Mr. Lewis R. Works, who resigned last December.

Mr. Geo. B. Massey, 2nd, Jun. Am. Soc. M. E., for the past four years Resident Engineer of the Bucyrus Co., in New York City, is now located in South Milwaukee, Wis., at the home offices of the company.

Col. Geo. W. Goethals, Chief Engineer of the Panama Canal, was the guest of the German Emperor on Mar. 10. Col. Goethals has been inspecting the Kiel Canal and other engineering works in Germany.

Mr. Stanley Colter, formerly of the contracting department of the Allis-Chalmers Co., of Milwaukee, Wis., has accepted the position of Sales Engineer of the General Concrete Construction Co., of New York City.

Mr. Frank Hooker Alfred, M. Am. Soc. C. E., General Superintendent of the Cincinnati, Hamilton & Dayton Ry., has resigned to accept the position of Assistant General Manager of the Pere Marquette R.R., with offices in Detroit, Mich.

Mr. C. C. Owens, Assoc. Am. Inst. E. E., for the past eight years with the New York City office of the Westinghouse Electric & Manufacturing Co., has been appointed District Manager in charge of the Detroit, Mich., offices of the company.

Mr. Thomas D. Pitts, M. Am. Soc. C. E., Division Engineer of the Baltimore, Md., Sewerage Commission, has been promoted to the position of First Assistant Engineer, succeeding Mr. A. M. Brosius, resigned, as noted elsewhere in these columns.

Mr. G. A. Trube, M. Am. Soc. M. E., Sales Manager of the Engine Department of the British Westinghouse Electric & Manufacturing Co., Ltd., of Manchester, England, has been made Manager of the Société Anonyme Westinghouse, with headquarters at 7 rue de Berlin, Paris, France.

Mr. Vincente Saucedo, Assoc. M. Am. Soc. C. E., has resigned the position of Chief Engineer of the Monterrey (Mex.) Water Works and Sewer Co. and of the Monterrey Railway, Light & Power Co., to enter private practice in engineering, with offices in the Banco Mercantil Bldg., Monterrey, N. L. Mexico.

Mr. P. L. Braunworth, Assoc. M. Am. Soc. C. E., until recently Principal As-

sistant Engineer for Mr. John M. Farley, M. Am. Soc. C. E., of White Plains, N. Y., is now associated with Mr. Farley under the firm name of Farley & Braunworth, Civil Engineers, with offices at 90 West St., New York City.

Mr. James Rowland Bibbins has established offices in the Hewes Bldg., San Francisco, Calif., for Mr. B. J. Arnold, Consulting Engineer, of Chicago, Ill. Mr. Bibbins will be the engineer in charge of the street railway investigation, which Mr. Arnold has undertaken for the Board of Supervisors of the city.

Mr. W. K. Vanderbilt, Jr., has been elected a vice-president of the New York Central Lines. Mr. Vanderbilt is 34 years old and a graduate of Harvard University, class of 1901. He has been Assistant to President Brown for nearly two years, and has been Vice-President of the New York & Harlem R.R. for about a year.

Mr. W. J. Harvie, Assoc. Am. Inst. E. E., Chief Engineer of the Syracuse Rapid Transit Ry., of Syracuse, N. Y., has accepted the position of Railway Manager of the operating department of J. G. White & Co., New York City, succeeding Mr J. N. Shannahan, resigned to become Vice-President and General Manager of the Newport News & Old Point Ry. & Electric Co., Newport News, Va.

Mr. H. R. Setz, for the past two years Chief Engineer of the Struthers Wells Co., of Warren, Penn., has been appointed Chief Engineer of the Otto Gas Engine Works, of Philadelphia, Penn. Mr. Setz has spent many years with gas- and oil-engine manufacturing companies in this country and Europe and will give his chief attention in his new position to the development of Diesel engines of the horizontal type.

Mr. C. DuB. Pollock, M. Am. Soc. C. E., formerly Assistant Engineer of the Bureau of Highways, Borough of Manhattan, New York City, and recently acting Chief Engineer, has resigned to accept a position as Chief Engineer in charge of paving and sewer work in Havana, Cuba. Mr. Pollock is a graduate of the Massachuetts Institute of Technology, class of 1894, and has been in the municipal engineering department of New York City for a number of years.

Mr. George F. Cotterill, of the firm of Cotterill & Whitworth, Civil Engineers, Seattle, Wash., was elected Mayor of Seattle on Mar. 5, by a majority of 665 votes over Mr. Hiram C. Gill, the former mayor, who was recalled last year. Mr. Cotterill is an Englishman by birth. His first engineering work was under Mr. James Owen, M. Am. Soc. C. E., of Newark, N. J. Mr. Cotterill moved to Seattle in 1884 and engaged in various engineering undertakings. From 1892 to 1900 he was Assistant City Engineer of Seattle. He was the Democratic nominee for Mayor in 1900, and for Representative in Congress in 1902, but was defeated in both instances. He was a member of the Senate of the State of Washington from 1907 to 1911, and in 1908 he was the Democratic direct primary nominee for United States Senator. Mr. Cotterill is said to favor single tax, municipal ownership and prohibition.

Obituary

Charles N. Mann, State Railroad Commissioner of Pennsylvania, died at his home in Philadelphia on Mar. 7. He was 72 years old.

David D. Drummond, Vice-President and Manager of the Chicago Portland Cement Co., of Chicago, Ill., died at his home in Oglesby, Ill., on Mar. 8.

Charles Thompson Harvey, an engineer on the construction of the Ninth Ave. Elevated R.R. of New York City, and on the construction of the Saulte Ste. Marie Ship Canal on the Great Lakes, died on Mar. 11, at the age of 87 years. He was in active practice up to the last few weeks of his final illness.

David S. Merritt, M. Am. Soc. C. E., of Tarrytown, N. Y., died Mar. 9. He was born at Caramel, N. Y., in 1858 and was a graduate of Union College. For a number of years he had been Engineer and Superintendent of the Tarrytown Water Department. He was a member of the American Public Health Association and of the American Association for the Advancement of Science. A widow survives him.

John S. Metcalf, of the firm of J. S. Metcalf & Co., Chicago, Ill., died at his home in Evanston, Ill., on Mar. 4, aged 65. Mr. Metcalf was well known as a builder of grain elevators, and as Consulting Engineer to the Canadian Pacific Ry. Co., in the construction of that company's elevators. He had been a member of the Western Society of Engineers for many years. He is survived by a widow and three daughters.

Engineering Societies

COMING MEETINGS

NATIONAL ASSOCIATION OF CEMENT USERS.
Mar. 11-16. Annual convention at Kansas City, Mo. Secy., Edward E. Krauss, Harrison Bldg., Philadelphia, Penn.

AMERICAN BOILER MANUFACTURERS ASSOCIATION.
Mar. 12-15. Annual convention at New Orleans, La. Secy., J. D. Farasey, East 37th St. and Erie R.R., Cleveland, Ohio.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 19-21. Annual meeting at Chicago, Ill. Secy., E. H. Fritch, 962 Monadnock Block, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.
Mar. 28-29. Annual meeting at New York City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

NATIONAL DRAINAGE CONGRESS.
April 10-13. Annual meeting at New Orleans, La. Vice-President, E. T. Perkins, First National Bank Bldg., Chicago.

AMERICAN ELECTROCHEMICAL SOCIETY.
April 18-20. Annual meeting at Boston, Mass. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

AIR BRAKE ASSOCIATION.
May 7-10. Annual convention at Richmond, Va. Secy., F. M. Nellis, 53 State St., Boston, Mass.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 14-16. Annual meeting at Chicago. Secy., F. H. Wentworth, 87 Milk St., Boston, Mass.

MASTER BOILER MAKERS ASSOCIATION.
May 14-17. Annual convention at Pittsburg, Penn. Secy., H. D. Vought, 95 Liberty St., New York.

AMERICAN RAILWAY ASSOCIATION.
May 15. Semi-annual meeting at New York City. Secy., W. F. Allen, 75 Church St., New York.

American Society of Mechanical Engineers—The Spring meeting will be held at Cleveland, Ohio, May 28-31.

American Public Health Association—Dr. William C. Woodward, of Washington, D. C., has resigned the secretaryship of this association, and Mr. Selskar M. Gunn, 739 Boylston St., Boston, Mass., has been elected to succeed him.

Vermont Society of Engineers—An organization under this name was effected at a meeting held at Burlington, Vt., Mar. 8, which was attended by some 40 engineers of the state. Officers were elected as follows: President, F. O. Sinclair, Burlington; Vice-Presidents, D. Williams, St. Johnsbury and J. E. Helyar, Brattleboro; Secretary, George A. Reed, Barre; Treasurer, A. E. Winslow Northfield; Directors, W. H. Vorce, St. Albans, H. M. McIntosh, Burlington, and A. C. Grover, Rutland. The business meeting at which the organization was completed was followed by a banquet in the evening. Mayor Roberts, of Burlington, gave the address of welcome and other addresses were made by Mortimer G. Barnes, C. C. Covert and Prof. A. E. Winslow.

Boston Society of Civil Engineers—The annual meeting of the sanitary section held Mar. 6, at the Boston City Club, was attended by 40 members and guests. Officers for the ensuing year were elected as follows: Chairman, George C. Whipple; Vice-Chairman, X. H. Goodnough; Clerk, Frank A. Marston; Executive Committee (in addition to the above), Almon L. Fales, Lewis D. Thorpe, Erastus Worthington.

Following the report of committees, Mr. Leonard Metcalf gave an informal talk on "Some Sewage Disposal Plants in Germany, France and England," which he visited last Fall. The talk was illustrated by a large number of excellent lantern slides showing the structural details of the more recent foreign plants.

American Institute of Electrical Engineers—The Directors, after reviewing the result of the recent nomination ballots, have mad the following nominations. It is announced that, following a provision of the constitution, the Board was guided but not controlled by the ballots:

For President, R. D. Mershon, of New York; for Vice-Presidents, W. S. Murray, of New Haven, A. W. Berresford, of Milwaukee, S. D. Spring, of Brooklyn; for Managers, C. A. Adams, of Cambridge, Mass., W. B. Jackson, of Chicago; J. F. Stevens, of Philadelphia, W. McClellan, of Albany; for Treasurer, G. A. Hamilton, of Elizabeth, N. J.; for Secretary, F. L. Hutchinson, of New York.

Official ballots for the officers will be sent out about Apr. 1, and also for the proposed constitutional amendments (see Engineering News, Feb. 8, 1912).

At the suggestion of the St. Louis section, a special committee has been appointed by President Gano Dunn, to investigate the U. S. patent system and to make recommendations for its improvement. This committee is made up as follows: Chairman, D. C. Jackson, consulting engineer and patent expert, Past president of the Institute; A. W. Berresford, manufacturer and patent expert; J. H. Bruninga, patent lawyer (nominated by the St. Louis section); James Burke, electrical engineer, inventor and manufacturer; F. P. Fish, patent lawyer; K. B. Miller, consulting electrical engineer and patent expert; M. I. Pupin, physicist, inventor and electrical engineer; and C. E. Scribner, electrical engineer, inventor and manufacturer. This committee is expected to confer with similar committees of other organizations.

Engineering Literature

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CORRESPONDENCE

The Obligations of the Engineer-Author; Further Comments on the Reviews of "Walls, Bins and Grain Elevators"

Sir—In ENGINEERING NEWS, Jan. 18, 1912, Prof. M. L. Ketchum makes some comments on the reviews of the first and second editions of his book on "Walls, Bins and Grain Elevators," which appeared, under the signature of the writer, in ENGINEERING NEWS of July 18, 1907, and Dec. 14, 1911, respectively. It is not the intention of the writer to provoke a controversy on the subject of these reviews, but he feels impelled to call attention to some facts that are of vital interest to every purchaser of an engineering book and, therefore, to every author of such a book.

There is a large class of men whose grievances are seldom heard, at least they are seldom adequately emphasized. This is because, as a rule, they do not write. Their thoughts are not distributed in weekly editions of ten or twenty thousand, nor crystallized in permanent books to be placed in libraries and in the hands of students and others. Authors and other writers have the advantage of having their thoughts placed before the public in these ways, and their point of view is apt to prevail with publishers and editors and to be accepted as public opinion or as the fulfillment of a public demand. In the field of engineering the men who do not write are the men who do the great bulk of the designing of the world as well as the execution. They stand the brunt of wrecks when any occur. They are the purchasers of periodicals and books and make their publication possible and profitable. It is meet, then, that the wishes of this body of men be considered.

There are two things that these men demand and have a right to demand, above all others in engineering matters. These are safety and simplicity. In addition they want practical methods of design.

It goes without saying that every form of construction built according to a book on engineering should be completely safe. When, therefore, a reviewer of a book points out that a structure built according to certain instructions in that book will prove unsafe, he points out a serious defect in the book. When the author subsequently refuses to alter a single syllable of his treatment, he is committing an unpardonable blunder and an offense against sound engineering, as well as an injustice to purchasers of his book. One purpose of making technical books is, or ought to be, to gather into convenient shape the data and knowledge on a certain subject, so that the user of the book is saved the labor of searching for these data and knowledge in current publications, society proceedings, etc. It ought to be possible for a man who has prepared himself by acquiring the ground principles of engineering science and a general engineering knowledge, in other words an engineer, to equip himself as a specialist in a given line by absorbing all there is in all the books on that subject.

These ideas of the writer may be exemplified in the following brief references to some points of difference between Prof. Ketchum's book and the reviews of it:

In the matter of simplicity of theory, Prof. Ketchum says that the writer's views are not in accord with most writers. The writer will gladly grant this, and he will venture to say that if the question were put to the vote of the members of the American Society of Civil Engineers as to whether engineering theory should be simplified, there would be an overwhelming majority in favor of simplification wherever the same is possible. We are not all 100%-teacher's-pet mathematical prodigies, as many engineering authors appear to be. Engineering designers do not care for mathematics as anything but a tool. Engineering authors, as a rule, love it as a science. Engineering designers do not care for the influence line nor the ellipse of stress, if their practical problems can be solved without them, which they can. Prof. Ketchum's improvement on Rankine's theory of earth pressures may be very nice as a mathematical gymnastic exercise, but his statement that the writer frankly refrained from expressing any opinion upon the discussion of the laws of semi-fluids is not accurate. Here is the writer's opinion: "The granular-mass (semi-fluid) theory of retaining walls is the most discredited theory that receives any serious notice on the part of writers." This is because it predicates forces that have no existence whatever from the assumed cause, for the reason that earth is not a non-cohesive granular mass.

Equivalent fluid pressure answers every purpose for determining the stability of retaining walls and is just as reliable as the granular-mass theory. Both are merely working assumptions and in the nature of the materials dealt with can never be anything else. The equivalent fluid pressure is vastly more simple to apply and to understand and besides facilitating the computer's work lessens the probability of errors. Prof. Ketchum might at least have mentioned this method and how it is applied, so as to give the purchasers of his book the option of using either method.

Instead of defending his defective reasoning in reinforced-concrete designing, Prof. Ketchum merely states that the reviewer's views are not in accord with most writers. Other authors have laid the same cuckoo eggs of logic in the nest of concrete engineering, but none of them have ever come back to mother (or father) them. To the average designer everything found in print is accepted as reliable. These defenseless waifs that have been cast on the literature of engineering through the medium of committee reports and books, and allowed to shift for themselves, are exceedingly numerous, and they are embraced as legitimate by the unwary designer.

Authors can ignore the wishes of the purchasers of their books—of course they can. The purchaser, along with the rest of the public, has to take what he can get. They can see humor in the situation, too, but they cannot thereby clear their conscience of the responsibility of wrecks that book-bred ignorance brings about.

EDWARD GODFREY.

Monongahela Bank Bldg.,
Pittsburg, Penn., Feb. 1, 1912.

REVIEWS

Steel

Reviewed by WILLIAM CAMPBELL*

THE METALLURGY OF STEEL—Vols. I and II. By F. W. Harbord, Assoc. R. M. S., F. I. C.; formerly Consulting Metallurgist and Analytical Chemist to the Indian Government, Royal Indian Engineering College, Coopers Hill; and J. W. Hall, Assoc. M. Inst. C. E., Consulting Engineer, Birmingham. Fourth edition, enlarged and revised. London: Charles Griffin & Co., Ltd. Philadelphia, Penn.: J. B. Lippincott Co. Cloth; 6x9 in.; pp. 933 + lxiii; 51 folding plates (112 figures) and 580 text illustrations; 122 tables. $12, net.

This work forms one of the metallurgical series edited by the late Sir William Roberts-Austen. The first edition, in one volume, was reviewed in these columns Oct. 13, 1904.

The present edition is divided into two volumes, the first of which embraces the manufacture and metallurgy of steel and the physical properties of the finished material, while the second volume takes up the mechanical treatment of steel. The scheme of treatment has not been altered. Mr. Harbord is responsible for Vol. I and Mr. Hall for Vol. II.

The chief changes and additions in the first part cover the latest modifications in openhearth furnaces and types of charging machines, and gas producers, recent developments in the basic openhearth and electric smelting. New photographs illustrate the section on metallography of steel and plans of several new plants in Europe and America have been inserted. In the second part the subject of power in steel works is treated more fully and new matter on the use of steam in exhaust steam turbines, on the generation of steam by solid fuel and waste gases, on the production of power by gas engines working with blast-furnace gases, and on electric driving of mills.

The authors are to be congratulated on the appearance of this new edition in two volumes, each treated by an authority in his line. The work is in general well proportioned, the treatment and style are delightfully clear and simple, while the heading of each topic in heavy type is a great help to the reader and might be followed in many books with advantage. In regard to illustrations the publishers have been more than generous and those given have been judiciously chosen and are to be noted for their quality, which is exceptional.

Of course, it is to be expected that the illustrations of practice are more of European than American. Yet the authors have endeavored to keep abreast with American improvements as well as their own, and so there is no doubt that on account of its excellence this book will be welcomed by that great brotherhood interested in steel—the engineers.

The chief criticisms are on the score of omission rather than commission. On the second page the definition of steel is for bessemer and openhearth and reads, "purified pig-iron, which, unlike wrought iron, has been cast whilst in a molten state and in which the carbon and impurities in the original pig iron have been reduced (1) by oxidation alone, (2) by dilution with a previously purified metal, or (3) by oxidation and dilution combined to such a point that the ingot cast is capable of being forged or rolled into blooms, slabs, etc."

In the first place, the definition ought to cover all steel, including crucible and that made in the electric furnace, and that can easily be done if we give weld-steels, blister, etc., a class by themselves, following Howe's suggestion. Secondly, the term ingot limits the definition. Steel is, in general, capable of being cast in a mass, malleable at least in some range of temperature.

In the chapter on the Basic Open-Hearth it is stated (p. 204) that the Duplex Process is not economically successful, while four times as much space is given to the Bertrand-Thiel Process. The section on the "general arrangement of the openhearth melting shop" shows the various methods of casting, but the modern car-casting ought to have been illustrated by the latest American plants, such as the new mills at Homestead, Bethlehem or Gary.

The Annealing of Castings (p. 237) given in one page and three of tables, is far too short for so important a subject and more details as regards temperature used, etc., would have been in place.

In the chapter on electric smelting the statement is made that steel of the highest quality equal to the best crucible steel can be made in England from cold scrap or by refining molten openhearth or bessemer steel at a price less than it costs to make crucible steel. Some American manufacturers claim that their electric-furnace steel is better than crucible steel.

The chapter on Carbon and Iron is perhaps the most open to criticism. The constitution of steel starts with Allotropy and the Carbon and Sub-Carbide theories. The sub-carbide $Fe_{24}C$ of Arnold is mentioned in some detail and then the ferrite-cementite curves given without showing that the two are hardly compatible. Surely the constitution of steel is based on the Iron-Carbon diagram in its entirety, therefore the logical way was to discuss steel as a solution even if it had to be owned that the last word has not been written on the Iron-Carbon diagram. If Campbell's Fe_3C is mentioned, why not Upton's Fe_4C also? After taking up the constitution of steel, the discussion of the metallographic examination of steel could have followed and then the heat treatment.

Several pages containing many excellent photomicrographs come toward the end of the book and would make most excellent reference for such a chapter as has just been suggested.

The section on typical steel plants, one page and four inserts (curiously placed between the Microscopical Examination of Steel and the Photomicrographs) shows the plans of the following plants: North-Eastern Basic Bessemer Steel Plant, Middlesborough, England, with four 15-ton converters; Frodingham Basic Open-Hearth Steel Works, England, with nine open-hearth and two 100-ton Talbot furnaces; the Gary plant; the Normanby Park Steel Works (in course of erection), England, Semet-Solvay ovens, three blast furnaces, 200-ton mixer, four basic open-hearth furnaces, etc.

Appendix 1 gives a summary of standard specifications adapted by Committee No. 1 of "the American Section of the International Association for Testing Materials," and then follows several pages of testing requirements in form of tables from the Engineering Standards Committee (British) under date of August, 1910.

The second part, on the mechanical treatment of steel, is also clearly and well written and gives after each chapter a bibliography which will be useful to the reader who wishes to go more deeply into the subject. Such a book is a great boon to anyone who wishes to understand the fabrication of steel without delving into original sources and yet get the more important details clearly and concisely.

In conclusion, if we take Stoughton's "Metallurgy of Iron and Steel" as the type of elementary textbook, Harbord and Hall's "Steel" is *the* advanced textbook on "Steel." We need the new advanced work on Iron also.

In regard to the workmanship of this book, the type, paper and illustrations are all of the high standard of excellence, on a par with the rest of the series, and similarly the binding is just as poor.

A "Monograph on Public Comfort Stations," by Frederick L. Ford, until recently city engineer of Hartford, Conn., forms the major portion of the fourth annual report of the Commission on City Plans, Hartford, Conn. (year 1910-11). The report is illustrated with numerous half-tone reproductions of photographs of both American and foreign stations. The greater part of the text is devoted to descriptions of American stations, for which a considerable amount of statistical and other information is given. Construction and operating cost, heating and ventilation, attendance, qualifications and rules for attendants and rules for patrons are given. Four or five pages are devoted to "The Importance of Detail Design." The monograph is a valuable supplement to the more elaborate "Report on Public Baths and Public Comfort Stations," made in 1897 by a committee appointed by the mayor of New York City.

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Sewage Sludge Treatment

Reviewed by GEORGE W. FULLER*

SEWAGE SLUDGE—Treatment and Utilization of Sludge, by Alexander Elsner. The Drying of Sludge, by Fr. Spillner; Translated by Kenneth and Rose S. Allen. Operation of Mechanical Sewage Plants, by Fr. Spillner and Mr. Blunk; Translated by Emil Kuichling, M. Am. Soc. C. E., Consulting Engineer. Sludge Treatment in the United States, by Kenneth Allen, M. Am. Soc. C. E., Engineer Metropolitan Sewerage Commission of New York. New York and London: McGraw-Hill Book Co. Cloth; 6x9½ in.; pp. 272; 42 text illustrations; 42 tables. $2.50, net.

The first half of this book is devoted to a comprehensive and careful review of German and English experience on the separation, treatment and utilization of sewage sludge. The first 117 pages are a translation by Kenneth and Rose S. Allen of a German article prepared about two years ago by Dr. Alexander Elsner, of Dresden. The difficulties of sludge treatment are fairly recognized. The viewpoint is that of the engineer who from inspection of numerous plants is convinced that there is no standard procedure which should be strictly adhered to at all plants, but that there are many valuable experiences which should be carefully weighed for the solution of each local problem.

The amount of sludge obtained under different conditions is reviewed as to European evidence. More than 30 pages are devoted to experiences in the removal of sludge from different clarification tanks in use abroad.

As to the reduction of water in sludge, Dr. Elsner's statements are helpful in showing the efficiency of various mechanical appliances. In particular are the descriptions of interest as to the use of centrifugal machines recently adopted at Frankfort and elsewhere. Costs are given in considerable detail, both for the removal of water from sludge and as to experiences in the utilization of the latter as a fertilizer, by availing of its calorific value through incineration, by the production of gas, and by the extraction of grease.

While the concluding remarks of Dr. Elsner do not lead to the inference that there is any one type of disposal of sludge adapted to all local conditions, it is very plain that substantial and rapid progress has recently been made in Germany in the practical developments in this field.

Next comes a résumé about 40 pages in length prepared by the same translators of an article written by Dr. Spillner, Chemist of the Emscher Association, on the "Drying of Sludge." This is a good review of the whole problem. Some details are presented more from the viewpoint of the chemist than of the engineer. Quantities and costs are given, apparently, wherever available.

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The most interesting part of Dr. Spillner's paper is devoted to the detailed work of himself and associates, to about the end of 1909, in the removal of water from sludge from the digestion chamber of two-story tanks of the Imhoff type. A detailed description is given of the character of the sludge, of the rate at which it is freed from water as placed upon the drying beds, with explanations of the influence which the retained gas has upon the drainability of this sludge.

Pages 173-91 contain a translation in somewhat condensed form by Emil Kuichling, of the results of the operation of some of the Imhoff tanks in the Emscher district by Dr. Spillner and Mr. Blunk, the operating engineer of the Association. The original article is somewhat more recent than the one by Dr. Spillner and deals more with the engineering aspects of the problem. In some ways it contains the most valuable data now available as to the liquid sludge, the drained or spadable sludge and the water leaving the sludge-drying beds. Analyses and costs of operation are given for representative plants.

The last 64 pages of the book are devoted to a review by Kenneth Allen of Sludge Treatment in the United States. Experience being more limited in this country than abroad, naturally the data are more meager than those in the preceding portions of this book. Nevertheless, many valuable data are given as to experiences at several testing stations and at a number of large plants, such as at Worcester, Providence, Plainfield, Mansfield, etc. Important data are given as to the sludge space to be provided in two-story tanks of the Imhoff type, and the sludge to be expected therefrom both from the flow of separate sewers and combined sewers.

Discussion is given of the volumes of sludge with varying percentages of water. This brings out the influence of varying specific gravity of sludge, an item which seems to be left out of the reckoning in the German data. For instance, on page 55, Dr. Elsner shows curves wherein the volume of sludge appears to vary inversely with the percentage of solid matters in the sludge." This would be true only if the solid matters had the same specific gravity as water. On page 179 it is stated that spadable sludge free of gas has a specific gravity ranging from 1.09 to 1.22. The volumes of sludge as obtained by actual measurement are doubtless recorded accurately for German plants, but there seems to be much room for improvement in tying up such data with sewages of different but known composition. Mr. Allen records the efforts in this regard at the Philadelphia testing station, and gives a range in figures showing the relation between weight and volume for sludges of different water content.

For a book of 272 pages the sanitary engineer will find in it a surprisingly helpful amount of practical information. It deals in a fair-minded way with a perplexing subject about which there are decided differences of opinion at a time when viewpoints are changing rapidly.

Mr. Allen speaks of the incredulity with which have been received the statements as to the absence of odors in the tanks of the Emscher district. Undoubtedly these tanks have to be carefully operated, particularly when first placed in service. Their benefits, as stated by Messrs. Spillner and Blunk, refer to absence of odor in the process of gasification and to obtaining a settled effluent in a fresh condition and without appreciable quantities of sludge in it. Among other reasons this is due to the absence of a flushing action by increased flows at times of storms, as the sludge drops at once into the digestion chamber and thus does not influence, and is not influenced by, the current in the upper chamber.

The book closes with the statement of Mr. Allen that it seems probable that the Imhoff tank in its present or modified form is destined to play an important part in sewage treatment in America for some time to come.

THE RELATIONS OF HUMAN AND ANIMAL TUBERCULOSIS. Part I, Final Report of the Royal Commission on Tuberculosis (Human and Bovine). London: Published by His Majesty's Stationery Office. Sold by Wyman & Sons, Ltd., Fetter Lane, E. C. Paper; 8⅛x13 in.; pp. 54. 6d., net; American price, 25c., net.

Those interested in either the public control of milk supplies or the prevention of the spread of tuberculosis through milk and meat and possibly through the agency of animals in other ways than the milk or meat supplies will wish to secure this brief and interesting pamphlet. The report sums up the results of ten years of experimental investigation, under most favorable circumstances, to determine whether: (1) tuberculosis in man and animals is the same; (2) whether reciprocal infection is possible; and "under what conditions, if at all, the transmission of the disease from animals to man takes place, and what are the circumstances favorable or unfavorable to such transmission."

In brief, the commission concludes: (1) that there is a human, a bovine and an avian type of tuberculosis; (2) that reciprocal avian infection may be left out of account, but that mammals and man may be reciprocally affected; and (3) that man, and particularly infants and young children, are liable to infection from cow's milk, and that meat of various kinds is a lesser source of human infection. It follows that no pains should be spared to exclude tuberculous cows from dairies which supply milk for human consumption.

Strength of Materials

Reviewed by LEWIS E. MOORE*

STRENGTH OF MATERIALS—By James E. Boyd, M. S., Professor of Mechanics, The Ohio State University. New York and London: McGraw-Hill Book Co. Cloth; 6½x9 in.; pp. 295; 200 text illustrations; 15 tables. $2.50, net.

The intent of this volume is, as stated in the preface, "to give the student a grasp of the physical and mathematical ideas underlying the Mechanics of Materials, together with enough of the experimental facts and simple applications to sustain his interest, fix his theory, and prepare him for the technical subjects as given in the works on Machine Design, Reinforced Concrete, or Stresses in Structures." The reader is supposed to have completed the integral calculus and a course in theoretical mechanics.

The first chapter is devoted to the different kinds of stresses and their effects, the elastic limit, modulus of elasticity, resilience, modulus of resilience, Poisson's ratio, and changes of volume under stress inside the elastic limit. The contents of this chapter are mentioned thus in detail because they are typical of the author's method of treatment. Some writers on mechanics of materials prefer to take up the simple cases of stress, beginning with tension, and mention only elongation in connection with deformation. Later on in the course, Poisson's ratio and the true amount of change in volume under stress are brought in but produce much less impression on the student's mind than their relative importance merits. The reason for this method of treatment is the fear that too many new and possibly confusing impressions will be made on the student's mind at one time. The author's method seems to be the better one, as the student will obtain at once a clear idea of the various elements affecting deformation and change of volume under stress. The presentation of this subject is very clear and concise.

The second chapter takes up the general subject of stresses beyond the elastic limit, and includes the stress-strain diagram, yield point, true and apparent elastic limits, reduction of area and per cent. of elongation. Typical stress-strain curves for various materials are given. A paragraph is devoted to explaining that the apparent stress per square inch and not the actual is used in computing the stresses per square inch at all points of the stress-strain diagram, and that this custom in connection with the necking down of a specimen is what causes the breaking fiber-stress to be apparently less than the ultimate. The chapter concludes with articles on the factor of safety and the effect of form on ultimate strength.

The third chapter treats of shear and shearing force. It brings out the fact that tension and compression are accompanied by shear and also that compressive and tensile stresses are generally caused when shear exists in a member. The chapter closes with the methods of failure in shear. The next chapter, on riveted joints, gives a clear idea of the stresses in and the methods of failure of a joint. It is weak on the design end, however, and gives the reader very little idea how to design an efficient joint.

The next chapter is confined to shear and moment in beams. Considerable space is devoted to illustrations of beams which are intended to show the different character of stress on different parts of various cross-sections. The proposition that the area of the shear diagram equals the moment is established and from it, by an entirely physical demonstration, the fact that the moment is a maximum where the shear is zero is deduced. This method of demonstration avoids the difficulties encountered when one endeavors to make a purely mathematical exposition of this proposition fit the case of concentrated loads. Shear and moment diagrams for various cases of loading, principally on simple beams, close this chapter.

Chapter VI takes up internal stresses in beams, first explaining the nature of the stresses, then developing the relation of the resisting moment to the fiber stresses and then finding the unit stress in the outer fiber. The neutral axis and section modulus follow. A paragraph is then devoted to graphical representation of stress distribution and another paragraph to stresses in a cross-section when a portion of it is stressed beyond the elastic limit, showing graphically how the stress diagram varies from a straight line under these circumstances.

The next chapter treats deflection in beams and finds the equations of the elastic curves for various cases. The method of attack to be used in finding the elastic curve and deflections for any simple beam, no matter under what loading, is also clearly indicated. The author states that the "stiffness of a beam may be defined as the load which will produce unit deflection" and goes on to say that we are not accustomed to express stiffness in this way, but use it as a relative term. It might be desirable to express stiffness in some such manner and the author's suggestion in this connection seems to be a good one.

Beams with more than two supports are discussed in the next chapter, first by means of the equation of the elastic curve and then by the theorem of three moments. Methods of calculation of moments and shears by applying this theorem are given. The author speaks briefly of forces in space and outlines concisely the method of handling such cases.

The next chapter takes up internal shear in beams, developing the usual methods of finding the intensity of shear at various points in a cross-section. Resultant stresses are discussed and illustrated in one or two typical cases of actual beams under definite loads. Methods of failure of beams are also treated and are accompanied by illustrations.

The following chapter is devoted to beams of special forms, including beams of constant strength, cast-iron beams, and beams of two or more materials, such as reinforced concrete. The treatment of the reinforced-concrete beam is very brief and might profitably have been somewhat expanded, particularly in the direction of shear and diagonal tension.

The next chapter is given up to bending combined with tension or compression and takes up such cases as eccentric loading on C frames, hooks, etc.

Chapters XII and XIII are devoted to columns. The method of presentation of this subject warrants somewhat extended comment. Chapter XII opens with a definition and a very carefully written illustration of column action, which brings out clearly the behavior of a column under load. The column theory is developed mathematically, taking into account initial eccentricity and using the elastic curve as a basis. The resulting formula would not be regarded as a practical working one by American engineers. Various applications of this formula are given as illustrations of column action. Curves are also shown for cases of varying eccentricity and Euler's formula is then developed as a particular case of the general formula. As is usual throughout the work, illustrative problems are placed at the end of each article and two at this point in the text are particularly noteworthy as typical of the author's method of developing the student's ideas. The first one is: "A yard stick, with the ends slightly rounded, was placed vertical with the lower end on a platform scale and a load was applied to the upper end. The load and deflection were measured. (A table of loads and deflections is then given.) Calculate EI from the last two readings (in the table) by Euler's formula."

The second one is: "The yard stick of Problem 1, supported as a beam at points 34 in. apart, was deflected ¾ in. at the middle by a load of 1 lb. at the middle. Find EI and compare the result with Problem 1."

An article on the effect of ultimate strength of material on strength of columns follows. The next two articles classify columns according to their end conditions and show what end conditions obtain in practice. The author also points out the uncertainties which arise in practice in this connection. Experimental re-

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sults are briefly treated in the next article. Chapter XIII is headed "column formulas used by engineers" and shows the basis for the various formulas commonly used, in general developing them, as far as possible, from the general formula of Chapter XII and showing the limits of and lines of demarcation between the various formulas and their methods and manner of use. An article is inserted at this point discussing the elements that combine to cause uncertainties in column design, the proper conditions under which to apply the various formulas, and the degree of safety with which the formulas may be applied in various cases. Failure of beams due to buckling of the compression flange is next treated and the failure of webs by buckling is taken up, and a formula of the Rankine form developed for web strength.

Chapter XIV is devoted to torsion, taking up stresses in shafts, relation between torque and angle of twist, relation of torque to work and torsion combined with bending or tension. The author recommends that "in all problems involving work done by shaft, solve first for the torque" and then use the torque in either the formula for the fiber stress or that for angle of twist. The chapter closes with articles on torsion combined with bending or tension, and helical springs. The next chapter takes up resilience in beams and internal work. Leaf springs are taken up from the work standpoint and the principles which govern design to obtain maximum resilience are enunciated.

The next three chapters, which take up centers of gravity and moments of inertia of plane areas and methods of computation without integrals, are intended to fit the book for use in such classes as may approach the subject without previous knowledge of this portion of it.

The nineteenth and last chapter takes up mechanical hysteresis, repeated stress and impact.

The method of development used by the author is along the lines of the philosophy of the subject, with the mathematics relegated to its proper position as a tool with which to work in reasoning. Physical (using the word to denote logical or philosophical rather than mathematical) demonstrations are used wherever practicable, and very carefully worded statements of principles are incorporated in all cases. The proper foundations, including statements of all assumptions, are laid for reasoning and the conclusions logically built up upon them. The style is extremely brief and lucid. The author has shown a clear knowledge of the difficulties which students find in comprehending this subject and has in consequence forestalled in the text many of the questions which are commonly asked in the class room. Mere substitutions in formulas is avoided wherever practicable, the idea evidently being that the formula is not an end in itself, but merely a short cut in many cases worth remembering. The illustrations and cuts are excellent.

The problems which occur at the ends of the articles are very well chosen and intended to advance the student step by step in his comprehension of the subject. While intended primarily for classroom use, for which it is one of the best existing texts, the essentials are presented in such brief and comprehensive form that the book should prove valuable as a reference volume for practising engineers.

Health Hints for City and Country

HEALTH ON THE FARM—A Manual of Rural Sanitation and Hygiene. By H. F. Harris, Secretary of the Georgia State Board of Health. New York: Sturgis & Walton Co. Cloth; 5x7½ in.; pp. 306; two text figures; 75c., net.

This volume deals chiefly with personal hygiene rather than either domestic or community sanitation, and has little to say regarding the various health problems peculiar to farm life, as distinguished from life in villages and cities.

After a little over twenty pages on "The Care of the Person" and about thirty pages on "Sanitation In and About the House," eight chapters (a hundred pages) are devoted to infancy and childhood, eating habits, foods and cooking. A chaper of some forty pages is headed "Seven Avoidable Diseases," and is followed by a somewhat shorter chapter on "Hygiene in the Sick Room." There follow two chapters dealing with emergencies, accidents and poisoning and their treatment.

The treatment of these various subjects is very uneven in quality. Typhoid, malaria and hookworm disease, their cause, and the precautions which should be observed against their spread, are treated clearly, concisely and with scientific accuracy. But the author, unfortunately, shows a strange lack of perspective in the arrangement of his material, and makes with the same dogmatic certainty statements which are largely matters of personal opinion on the one hand, and, on the other, well-established scientific facts. The class of readers to whom this book is addressed, not being able to discriminate between facts and fancies, and shrewdly noting doubtful value or manifest absurdity of some of its teachings, will be likely to condemn in toto a book which contains much valuable instruction. After having read that breakfast foods, of which oatmeal is said to be the worst, "are nothing but bread, and very bad bread at that," that all vegetables, including the potato, and excluding asparagus and the legumes only, either have very little nutritive value or "are exceedingly apt to produce intestinal disturbances," or both; after being told that the opinion "almost universally shared by both medical men and the laity" that fruits are wholesome is erroneous, and that apples, especially, "can rarely be eaten without ill effects, however mellow and palatable they may be;" after being advised that boys should not be sent to school until 12 or 14 years old; after being assured that "in the average wooden dwelling there are so many cracks that good ventilation is generally secured without opening doors and windows," the reader will be likely to doubt the soundness of much of the really good advice that is given on the care of infants, the importance of diet and sleep, the avoidance of patent medicines, proper methods of waste disposal, and many other subjects relating to health, in which the average householder needs instruction, and regarding which there is general agreement among hygienists and sanitarians.

The relatively small space devoted to sanitation as contrasted with personal hygiene may be partly explained by the fact that there has already been published in the same series ("The Young Farmer's Practical Library") a volume entitled "Home Waterworks" (see this Supplement for Aug. 17, 1911). That volume covered its subject in considerable detail and also took up sewage disposal briefly, though very unsatisfactorily.

The present volume has very little to say regarding sewage disposal, but has a quite satisfactory section on privies and the disposal of night soil. We characterize this section as "quite satisfactory," although the author does not seem to be aware, or else ignores, the investigations being made by the United States Public Health and Marine-Hospital Service, which appear to be leading Doctors Stiles, Lumsden and Roberts to believe that the disposal of night soil by burial in the earth is extremely dangerous. Possibly the author of this volume is not convinced of the soundness of the teachings of the investigators just named. Certainly, more data must be accumulated before their teachings can be accepted without question.

Under water-supply, the author dwells on the possibility of disease germs being blown here and there by dust, and makes the direct statement that should they find access to cisterns they "would be likely to multiply." It would be interesting to know what disease germs multiply in cisterns.

Several illustrations are referred to in the text of this book which appear to have been entirely omitted. Presumably this defect will be made good in a future edition.

The style of this book is as uneven as its contents. While many portions, notably the introductory chapter, are written in a concise, vigorous and spirited manner, much of the book is badly written, and grammatical errors are not infrequent.

The publishers deserve credit for printing the book in large, clear type—which gives a particularly appropriate setting for a book on health.

British Domestic Sanitation

Reviewed by CHARLES B. BALL*

DOMESTIC SANITATION AND PLUMBING—By A. Herring-Shaw, R. P. C., Assoc. Royal San. Inst. In two volumes. Part I: Materials and Their Uses; Soil, Waste and Vent Pipes; Sanitary Fittings; House Drainage; Cesspools; Disposal of House Sewage. Part II: Water Supply; Domestic Hot-Water Services; Warming and Ventilation of Buildings. London: Gurney & Jackson. Cloth; 5½x9 in.; pp. 318 and 358; 300 and 264 illustrations in text. Part I—6s. 6d., net; Part II—7s. 6d., net; American price, $2.60 and $3, net.

In comparing this book with the existing works on house plumbing and heating, especially those by English authors, the reviewer notes the many evidences of recent advance in these sanitary arts. The purpose of Prof. Herring-Shaw to "treat the subject matter on organized and progressive lines" has been well accomplished. The book excels in its statements of the principles of design and of the considerations which should be in mind when selecting any sanitary fitting (fixture) as well as in the application of these criteria to special fixtures, as water closets, urinals, etc. These features are noteworthy because such standards are usually lacking in books on plumbing published in the United States. At the same time, the difference between American and English types of construction and uses of materials is made apparent to the American reader on nearly every page.

Part I, on Materials and Their Uses, contains throughout interesting illustrations of types of design which would not satisfy the critical minds of engineers on this side of the ocean. Such a case is Fig. 66, p. 93, showing four basins, each trapped and with the traps vented to a vent pipe placed entirely below the basin bowls, where it might easily perform the function of a waste without indicating its perverted use. On the same page, Fig. 65 shows a basin inside of a building discharging into an open, outside disconnector with a 1-in. vent pipe extending about 7 ft. above the ground on the outside.

The opening pages of Chapter XIV, devoted to the drainage of buildings, are of exceptional value, as the author states fully the points involved in the construction of drainage lines and the choice of materials therefor. His advocacy of cast-iron pipes for foul water drains, which we believe to be sound, is in striking contrast to the opinions of former English writers on plumbing and drainage, excepting Jensen (1908), and is confirmatory of the statement by the latter (p. 3, "Cast Iron House Drainage"): "We are, therefore, steadily and surely sealing the doom of the stoneware pipe drain and giving preference to iron piping."

The fifteen conditions laid down for the construction of a house drain (pp. 213-215) are excellent for cases (fortunately prevailing in only a few American cities) where earthen drains are still laid. Exception should, however, be taken, in harmony with the views of the preponderance of sanitary authorities, to the disconnecting trap and fresh-air inlet prescribed by the author, at the boundary line of the private ground.

The assumption that soil and waste stacks will be generally placed outside of the walls of the structure leads to some interesting limitations of the arrangement of the plumbing, as on p. 186, where the author cautions that "baths should, wherever possible, be fixed near to outside walls, so that the length of waste pipes inside of the building will be reduced to a minimum." While careless designers here often unnecessarily lengthen waste pipes, our best practice avoids proximity to outer walls and windows in the location of bath tubs.

The exterior location of soil pipes also makes almost imperative the placing of joints in inaccessible positions in the wall, a practice deprecated by the author (p. 80), but frequently illustrated in the work (pp. 101, 129, 135 and 137). Few American engineers will agree that cast-iron pipes "cannot be used for inside work with facility and safety" (p. 87), the principal reason assigned being the danger of the "rapid rusting action which would occur on their exterior surfaces when fixed in inclosed positions where they are not likely to receive attention as regards painting." This danger is considered here to be practically negligible.

We should also disagree with the conclusion (p. 95) that portland cement is a suitable material to use for the joints of cast-iron waste pipe, not even admitting with the author (p. 150) that "the use of such a rigid material as portland cement for jointing purposes is debatable."

The mild endorsement given by the author to enameled cast iron as a material for bath tubs and sinks is tempered by the fear that the coating will be "easily fractured" and that the discharge of hot water into the fixture when cold will "rupture the glazed surface." Enameling is now so well performed in the United States that the use of cast iron thus treated is very general in all grades of installations and is fully justified by the durability of the coatings. It is now rare to discover any defect in the surface of an enameled fixture, other than a water closet, which is not due to extreme carelessness in handling before installation.

Part II treats of three general subjects: Water Supply; Domestic Hot Water Service; and The Warming and Ventilation of Buildings.

Each portion constitutes a well balanced treatise upon its subject matter with less variation from American practice than is found in Part I. A statement which will attract the attention of the American reader is found (p. 107) in the definition of an intermittent system of water supply as one "in which the water is turned on in the distribution mains for a portion only of each day," a condition almost unknown in the United States. It may also be noted that domestic water-supply systems in England (p. 192) are not allowed to be connected directly to street mains and are, therefore, never operated constantly under pressure, as is almost invariably the case here.

The author emphasizes in a number of places (pp. 143, 158, 178 and 206) the danger of a direct connection of a water-supply pipe to any plumbing appliance, be it urinal, water closet, slop sink or bath. While it is doubtless true that the hazard of such a connection is increased by the frequent cutting off of water pressure in the mains, as in the English cities, there is here too little appreciation of the possible contamination of the entire supply where the loss of pressure is only occasional or accidental.

A difference in the use of piping materials is noted on p. 285 in the statement that "cast-iron pipes are generally used for hot-water heating purposes for circulating mains more than 2 in. in diameter," as practically no cast iron is so used here. The extended references to copper pipes used for water supply also suggest a practice that is uncommon in the United States.

The 25 pages devoted to ventilation present the essential principles in excellent form with some description of the more common appliances for providing air changes.

We in the United States can agree with the expression by the author of the need of standardization of the requirements of local authorities as to the strength of cast iron soil pipes and other matters both of principle and detail and with his declaration that some movement is necessary to obtain uniformity of by-laws and regulations governing plumbers' work and a more strict enforcement through close supervision of existing requirements.

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On the whole, the work will be useful to all who care to know the best types of design and construction and the principles which underlie both.

Cost Accounting as an Index of Production

MAXIMUM PRODUCTION IN MACHINE-SHOP AND FOUNDRY—By C. E. Knoeppel. New York: The Engineering Magazine. Cloth; 5x7½ in.; pp. 365; 34 text illustrations. $2.50, net.

More sermons on "scientific management," the casual observer will say! Perhaps so, but the sort of sermons which need to be heard the length and breadth of the land if there is to be any relief from the oppressive cycle of higher prices and higher wages, for the preacher's head may be in the clouds, but his feet are still on the ground—something which cannot be said of all his contemporaries.

Mr. Knoeppel, in spite of a broad title, concerns himself mostly with a single phase of the subject—the very essential one of accurately determining true cost of each process of manufacture. Incidentally, the sort of accounting that is outlined is made to show the progress of work and the presence of leakage in supplies. The author shows great impatience with systems that yield only grand totals, or general post-mortem details; he wants to have, as an executive, regular reports on the construction, reconstruction and maintenance costs of the plant for which he is responsible; data on the material issued and labor expended to date on current orders in his shop; figures of direct production cost, overhead burden distribution and profit on orders just being shipped; exact knowledge of the cost of definite classes of work for use in future bids. Much of what the author has written is of a general nature and quite applicable to a very wide range of ordinary manufacturing; but when specific illustrations are drawn they are consistently of foundry works.

There is nothing here that tells how many motions one molder must make, how wet the sand must be, how the cores are to be handled, and the other thousand details that the consulting efficiency-izer may impose. The author goes to even more preliminary matters, to show any intelligent and open-minded executive how to find out first what is the cost of his present operations. That done, the actual figures are available for comparisons with standards which the executive may set up as judgment dictates. By that time he will be well started in "efficiency engineering" or "scientific management."

The first chapter compares results of good and useless accounting; the second shows the evils of complex organization with split responsibilities compared with simple and direct schemes; the third returns to accounting to outline the basic idea that "whatever is produced for commercial use should absorb all that enters into making that production possible.". Then comes a discussion of classification of general expense into maintenance, new construction and replacement or reconstruction. After this are a couple of chapters on keeping the various operations on an order simultaneously well advanced to insure prompt deliveries and to eliminate delay and confusion.

All this covers a trifle less than half the book—the other part relates specifically to foundry work. Among the more notable chapters here are those on the logical apportionment of overhead burden. The effect on the business of using tonnage of castings and direct labor as the basis of apportionment are discussed and the necessity is shown of using both. While this discussion is directly concerned with iron founding, no great effort is needed to isolate the principles for application elsewhere.

THE AMERICAN YEAR BOOK. A Record of Events and Progress, 1911. Edited by Francis G. Wickware, B. A., B. Sc., under direction of a Supervisory Board representing national learned societies. New York and London: D. Appleton & Co. Cloth; 5x8 in.; pp. 863. $3.50, net.

The second issue of "The American Year Book" continues the high standard of utility and general excellence set by the first issue. As befits a volume credited to the coöperative efforts of the technical and "learned" societies of America, a considerable proportion of the contents of the "Year Book" deals with engineering, scientific and industrial topics.

No explanation is given of the continued omission of the American Society of Civil Engineers from the list of coöperating societies. This omission is all the more notable because the other three of the four great national engineering societies are included, as also the American Society for Testing Materials, the American Naval Architects and Marine Engineers and the American Institute of Architects. Certainly if any engineering or technical society would naturally find a place here, it would be the American Society of Civil Engineers. The omission, however, has more to do with a partial failure to carry out the coöperative idea, of which so much is made, than with the character of the contents of the volume.

Broadly speaking, all the engineering subjects have been put in good hands, and while the space accorded to most of them is altogether inadequate to give more than a sketchy idea of the pertinent events of 1911, this also applies to other departments of the Year Book and is perhaps inevitable in any volume which attempts to cover so broad a field within such a narrow space and at such a reasonable price for the book itself. The actual delivery of the volume within the first month following the year it is designed to cover is a credit to contributors, editors and publishers alike.

CLAIMS: FIXING THEIR VALUES—By George F. Deiser, A. B., LL. B., of the Philadelphia Bar; and Frederick W. Johnson, formerly Assistant General Claim Agent. New York and London: McGraw-Hill Book Co. Cloth; 5⅝x8 in.; pp. 158. $2, net.

The settling of claims that injured parties have against corporations responsible for the injury is a business in itself and one that requires, added to a deep knowledge of human nature, more than a smattering of law and besides, in the case of public-service corporations, at least, some acquaintance with engineering. It is rather difficult to prepare a textbook which will serve to instruct the beginner in such work because the principles underlying its practice can hardly be codified, but it is possible for an experienced claim agent to set down in order the nature of the work and the various factors influencing its performance. Such a book is the one before us. It is more in the nature of a law book than an engineering text, but for some classes of engineers it may prove useful.

A BRIEF LABORATORY GUIDE FOR QUALITIVE ANALYSIS—By Arthur E. Hill, Ph. D., Associate Professor of Analytical Chemistry, New York University. Easton, Penn.: The Chemical Publishing Co. London: Williams & Norgate (14 Henrietta St., Covent Garden, W. C.). Cloth; 5x7 in.; pp. 80. $1, net.

The author explains the preparation of this very brief manual for the qualitative chemical analysis of unknown inorganic substances by his experience in trying to abbreviate some of the recognized handbooks to fit a course of some 85 hours in the laboratory and 15 in the lecture room. The recognized methods of procedure have been clipped by eliminating the group searches for cadmium, strontium and the precious metals.

First the author gives a brief outline of the general problem of analyzing an unknown inorganic substance such as commonly met with. Then there is a schedule of the procedure, and this is followed by the detailed steps.

CITY PLANNING. Proceedings of the Third National Conference, Philadelphia, Penn., May 15-17, 1911. Boston, Mass.: Flavel Shurtleff, Secy., 19 Congress St. Cloth; 6¼x9½ in.; pp. 293. $1.50, net.

The proceedings of the congress mentioned centered chiefly around public buildings and their location; buildings in relation to street and site; condemnation, assessments and taxation in relation to city planning; street widths; legal aspects of city planning, and the municipal real-estate policies of German cities. A few British city planners contributed materially to the congress, and some well known American engineers and civic architects took part.

Valves and Valve Gears

Reviewed by JOHN J. FLATHER*

VALVES, VALVE-GEARS AND VALVE DIAGRAMS—By Franklin DeR. Furman, M. E., Professor of Mechanism and Machine Design, Stevens Institute of Technology. Hoboken, N. J.: The Author. Cloth: 8½x10¼ in.; pp. 130; 152 text illustrations. $3.75, net.

The present work is the outgrowth of a series of notes prepared in neostyle form and used by the author in his classes during the past eight years. While these notes have been written with especial reference to the course in mechanical engineering at the Stevens Institute, an examination of the book discloses a well arranged and systematic presentation of the subject which should make it generally available as a text and reference book in valve design, not only for the student in mechanical engineering, but for the practicing engineer and draftsman as well.

A commendable feature is the arrangement of the material and presentation of problems to conform with the methods in vogue in the best drafting rooms where the design of valves and valve-gears is being carried on in connection with actual construction.

The various published treatises on valve-gears have been drawn on where it has been found advantageous, and illustrative applications are noted of the Bilgram diagram, the Valve Ellipse, the Reuleaux diagram, and others; in some cases original methods have been presented, but for the most part the Zeuner diagram has been used, than which it is doubtful whether any other system or combination of methods is generally as effective or as readily comprehended by the student.

The first section of the book is devoted to a discussion of the simple steam engine. The elements of valves and valve-gears are defined, and the Zeuner diagram is deduced. Exercise drills in the use of the Zeuner diagram follow, and practical methods are given for proportioning the plain D- and the Allen valves, equalizing cut-offs and other phases of the cycle, and for determining the width of ports under varying conditions; the limitations of these valves are also pointed out.

Various valve diagrams are presented in Section II, which is followed by a discussion of the several types of valves ordinarily used in engine practice, including piston valves, double-ported valves, Meyer, Corliss and other forms. The lay-out of the Meyer and Corliss valve-gears is shown and the methods of design are applied to various practical problems in which the details are worked out very fully.

Section IV is devoted to a discussion of the usual shaft governors ordinarily met with in practice. These are treated kinematically, with especial reference to the relation of the Zeuner diagram and the eccentric, under varying conditions of load. This is, of course, logical, but it is to be regretted that the limitations of the work do not permit a complete presentation of the subject under this caption, for the inclusion of the methods of calculation in governor design suitable for class-room and drawing-room applications would make the work more valuable, as a self-contained textbook.

In the last section link motions and other valve-gears are very fully discussed and drawing-room methods of design are given for the more common forms, including the Stephenson, Gooch, Walschaert, Hackworth, Porter-Allen, and other types.

Among the more recently developed methods of steam control discussed in this section are the Baker valve-gear used in connection with American locomotives, in which neither eccentric, nor curved link is employed; and the Lentz gear for stationary engines which makes use of the double-seat poppet valve controlled by a shaft governor and straight-slot eccentric. Examples of steam turbine gears controlled by the governor, as used in the Curtis and Westinghouse turbines, are also discussed at some length.

Professor Furman has been very successful in his arrangement of material and treatment of the subject which is especially well adapted to the work of instruction. Numerous problems to be worked out in the drawing room accompany the text and the method of procedure in each case is logically presented. The introduction of preliminary free-hand exercises for drill before taking up the more detailed drafting-room problems is an excellent feature which must appeal to the teacher of machine design.

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Mining Without Timber

Reviewed by LOUIS D. TRACY*

MINING WITHOUT TIMBER—By Robert Bruce Brinsmade, B. S., E. M., formerly Professor of Mining Engineering at West Virginia University; Mem. Am. Inst. M. E., Coal Mining Inst. of Am., Soc. Prom. Eng. Ed., etc. New York and London: McGraw-Hill Book Co. Cloth; 6x9½ in.; pp. 309; 146 text figures. $3, net.

Professor Brinsmade treats a subject of vital importance to the mine superintendent of today. As most aptly stated in his preface:

> The rapid depletion of the primitive forests of America by fires and ax in recent years has raised the price of wood so rapidly that the mining industry is becoming alarmed as to its future supply of the big timber, of which it has been hitherto such a prodigal consumer.

It is the evident purpose of the author to emphasize those mining methods which will obviate to the greatest degree the use of other supports than the pillars and ribs of the ore itself. The use of steel and other supports of mine shafts and tunnels has been left to other writers.

The first chapter is devoted entirely to explosives and their use in mining, and much space is given their chemical composition and physical characteristics. To one not in almost daily contact with a chemical laboratory, much of the context would be rather unintelligible. This adds little if anything to the value of the book for those to whom it would be most useful, namely, superintendents and managers of mines with a limited technical education but with a valuable practical experience behind them. Aside from this tendency to be too technical, the chapter is interesting and profitable.

In the following chapter the theoretical principles involved in blasting are discussed in a manner which may be easily understood by the average mine foreman. Passing by Chapter III, which is given over to the relative merits of high and low compressed-air systems, we come to the chapter devoted to the "Principles for Controlling Excavations," in which the author has worked out in detail the theory of roof fractures and evolved principles for the protection of the surface. This is one of the most interesting and valuable chapters in the treatise, and can be read with profit by all connected with mineral development.

In Chapter V, on mine drainage, the author covers very thoroughly the problems of drainage from the viewpoint of meteorology, geology, hydraulics and mechanics. He well says:

> Instead of studying water conditions beforehand as a basis for drainage equipment, a too common way is to try to fit the pumping plant to the inflow after it has appeared. This policy may mean a drowned mine, and weeks of delay for the installation of larger pumps and the clearing from water; it may mean a set of makeshift pumps of the wrong size and of low efficiency which may be wholly unnecessary owing to the feasibility of natural drainage.

Next, open-cut surface shoveling is fully discussed. The author not only covers the methods in use in the well known iron-ore fields of the Mesabi Range in Minnesota, but also covers copper mines in Utah and Nevada and the coal fields of Illinois, and eastern Pennsylvania. A description of the manner of prospecting and locating the orebodies in the iron fields of Cuba is given a prominent place in the chapter.

Passing by Chapter VII, which covers ground somewhat similar to that of the preceding chapter, we come to the purpose of the book, the supporting of the roof with the use of as little timber as possible. In this chapter, as well as in the seven or eight following, Prof. Brinsmade has gathered information regarding the different systems of blocking out and recovery of ore in vogue in all parts of the world, where the use of timber supports has been minimized. The subject is exhaustively discussed and some forty

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examples are given of actual operations from Alaska to Mexico, and from Nevada to South Africa, plentifully illustrated by cross-sections and plans of the workings. To one in charge of a metal mine, these chapters would seem to be of great value, and the ideas contained therein might be followed with profit. Four chapters are devoted to coal mining, with an especially interesting discussion of the long-wall and the pillar systems.

At the end of the treatise the author has summed up in a concise manner the various systems discussed in previous chapters, with their advantages and disadvantages. The last chapter is devoted to the "Principles of Mine Evaluation," which would be of great assistance to a mine superintendent or engineer who might be required to give an estimate of the value of the property under his charge. A list of references to valuable published articles closes the volume.

The book is well worth a place in the library of anyone connected with the development of mines.

Translation of a German Book on Marine Steam Turbines

Reviewed by ERNEST N. JANSON*

MARINE STEAM TURBINES—(Forming the Supplementary Volume to "Marine Engines and Boilers.") By Dr. G. Bauer, Director of the Vulcan Works, Stettin; and O. Lasche, Director of the A. E. G. Turbine Works, Berlin; Assisted by E. Ludwig and H. Vogel. Translated from the German and edited by M. G. S. Swallow. New York: The Norman W. Henley Publishing Co. London: Crosby Lockwood & Son. Cloth; 6x9½ in.; pp. 214; folding chart in pocket of cover and 103 text illustrations; 18 tables. $3.50, net.

On the whole, the book before us may be considered the most satisfactory yet published on the subject of marine steam turbines. The introductory chapter deals with the advantages of steam-turbine installations, as compared with reciprocating engines, touching in a general way on the items of steam consumption, weight, space and maneuvering qualities.

According to the general classification of steam turbines given in Section III, having reference to the number of shafts necessary with the different types of turbine, at least three shafts are required with turbines of the Parsons type for the utilization of the full expansion of the steam, while the same may be accomplished on only one shaft with the Curtis turbine. While, generally speaking, this is quite true, this system of classification does not hold good when reference is being had to some of the more recent arrangements with the two types alluded to. Thus, with Curtis, when dividing the unit into two separate turbines on each shaft and cross-connecting the high-pressure unit on the one shaft with the low-pressure unit on the other, the arrangement occupies two shafts, instead of one, for the full expansion. This arrangement is being resorted to in order to gain economy in steam consumption at half power. Also in combination machinery with the Parsons turbine the expansion of the steam is done in the one turbine driving the center shaft. This is possible by the limited pressure range to which the turbine then is subjected. Moreover, it is not quite accurate to state that no other types of turbine apart from Parsons and Curtis have been practically tried on a large scale. The types known under the names of Rateau, Zoelly and Melms-Pfenniger, if they really represent individual types, have been and now actually are being tried out in good-sized installations with considerable success.

In Table 3 of Section I, Part II, the S. H. P. given for the "Salem" in comparison with the i.hp. for the "Birmingham" at the different speeds designated shows propulsive efficiency of the former to be superior to that of the latter, while as a matter of record the reverse was proved on the official speed trials, as well as in series 2 of the standardization trials. In Table 6, the reviewer notes with some degree of surprise that evaporative results have been obtained with the Schultz-Thornycroft water-tube boiler equalling shell boilers fitted with Howden draft and exceeding the Yarrow boiler by 30%. The fuel consumption converted to pounds per square foot of grate surface from that given in kilograms per square meter, second and third columns, is erroneous and requires rectification from beginning to end.

As is commonly the case with the publication of a first edition of a book, minor errors appear in various instances. Thus it is found in Table 10 that the saving in coal due to superheating in accordance with figures furnished is not 92% but 9.2%. Similarly, in Table 15 the limiting value on the projected surface for propellers of turbine propelled vessels, figured from the formula given in paragraph 99, could hardly be meant to be, for torpedo boats of 30 knots and above, from 0.252 to 0.322 lb. per sq.ft. of projected blade surface, but rather from 25.2 to 32.2 lb. per sq.in. of that surface, all of which figures, however, are too high for best efficiency. It is doubtful that the dryness fraction of the steam would be less in the boilers at reduced speed, when not being forced, than at full speed, when being forced, as given in paragraph 23.

Apart from the errors which seem to exist in some of the figures contained in Table 15, the method given in the chapters on Shafting and Propellers, Part V, for determining approximate dimensions of screw propellers for different classes of vessels, by making said dimensions conform to certain limiting figures for tip speed and thrust per unit area, is excellent, and while in itself not new among designers and builders, its exploitation as a method promotes its use.

The first four parts of the book refer to design of turbines of Parsons and the so called A. E. G. type, which is a combination of Parsons and Curtis. The plain and understandable language used in the descriptions and the simple reasoning in the derivation of the formulas are particularly pleasing and will greatly aid the users of the book in their various purposes and references. The reassuring effect rendered by citation of various figured examples is of especial value to the student in taking up the subject.

The book as a whole fills a gap of long standing, which the authors and the translator should feel gratified in having filled.

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ROCK DRILLING—With Particular Reference to Open Cut Excavation and Submarine Rock Removal. By Richard T. Dana and W. L. Saunders. Data compiled by Construction Service Co. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. 319; 127 text figures. $4, net.

The purpose of this book is best expressed in the following phrases from its preface:

> The rock drill is a machine of many parts, sizes and shapes, and there are many ways of using it, some of which are better than others, and one of which, for the particular purpose in view, is the best of all. To establish the fundamental facts for determining this "best" way for any given conditions, and to place these facts at the disposal of engineers and contractors, the Ingersoll-Rand Co. have instituted an investigation into the economics of drilling work, the results of which are herewith presented in the hope that the book will mark a step forward in the effort to place the study of rock drilling upon a scientific basis. Most of the data was gathered by the Construction Service Co., Consulting Engineers, of New York, and some of it by Mr. Gilbert H. Gilbert, Consulting Engineer; and the whole worked into its present form by the Chief Engineer of the Construction Service Co. [Mr. Richard T. Dana] in collaboration with Mr. W. L. Saunders, President of the Ingersoll-Rand Co.

The basis of the book is the very complete, one might almost say complicated, time studies made upon the actual workings of the drilling plants at about two dozen different locations. From these studies, tabulations have been prepared from which estimates as to the costs of a drilling operation in whatever material may be estimated. As a necessary accessory to these studies and deduction there is also included much material on the technique of drilling, which is very complete and instructive.

WATER-WORKS EXTENSIONS. Report to the Board of Commissioners of Kansas City, Kan. By Lee Riley and Wynkoop Kiersted, Engineers. Kansas City, Kan.: The Board. Pub. Doc. Paper; 6x9¼ in.; pp. 54; illustrated.

The improvements described in this report cost about $900,000 and included a new pumping station and equipment, a settling basin, and a mechanical filtration plant, with a provision for the use of hypochlorite for disinfection. Half-tone and line illustrations add to the interest and value of the report.

Bridge Design

Reviewed by A. W. CARPENTER*

BRIDGE DESIGN—Being Part III of "A Text Book on Roofs and Bridges." By Mansfield Merriman, M. Am. Soc. C. E., and Henry S. Jacoby, Professor of Bridge Engineering in Cornell University. Fifth edition, partly rewritten. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. 422; seven plates and 184 text illustrations. $2.50, net.

The revisions in the new edition of this popular standard text- and reference book consist in the replacement of two chapters by entirely new ones, and of one chapter by a partially new one; modifications in other chapters toward keeping the book in step with progress in practice; the introduction of new standard designs and a number of new photographic views of bridges; the extension of the references to engineering literature, which have formed a feature of the volumes of this work, to include the recent publications, at the same time culling out many out-of-date references.

The new chapters are those on "Fabrication and Erection" (formerly "Bridge Shops and Practice") by Warren B. Keim, Assistant Engineer, Bridge and Construction Department, Pennsylvania Steel Co., and on "Highway Bridges," by F. O. Dufour, Assistant Professor of Structural Engineering, University of Illinois. The partially new chapter is that on "Railroad Riveted Bridges."

The chapter on "Fabrication and Erection" seems to be a good exposition of high-class modern bridge-shop practice and of modern methods of bridge erection. Occasionally the author mentions practices which are not general without stating their limitations, but, on the whole, this chapter covers its ground very fully and satisfactorily.

Shop operations are described in sequence and in considerable detail, including the various tools used. Some of the newer practices mentioned are the use of paper cardboard for templates to replace the more expensive white-pine lumber and the use of high-speed tool steel for drilling and reaming without the aid of lubricants. Shop painting is given unusual attention, also the considerations for shipping material.

Some of the shop practices described which the reader might infer to be general, but which the reviewer has not, in his experience, found so, are the following: The testing of assembled turntable centers for the force required to turn the same, by means of spring balances; the complete assembling of riveted trusses, which are to be later shipped "knocked-down," for the reaming or drilling of the field connection holes (although this is probably the best and safest practice and the reviewer hopes it will become general). In stating the reasons for reaming, the important feature of the removal of material injured by punching is overlooked.

The articles on erection cover the ground very fully and are accompanied by excellent photographs showing the application of the different types of erection equipment on structures in the process of erection. The general essentials to the erection of ordinary bridges are well outlined, the importance of preliminary study of erection requirements and determination of the methods to be followed being pointed out. The various usual methods are classified and described under the headings of (1) Simple Erection (subdivided into crude, gin-pole, derrick and gallows-frame erection), (2) Derrick Car Erection (including locomotive cranes and floating derricks), (3) Falsework and (4) Travelers. The derrick car and its applications are given particularly full attention, this being described as "An ideal erection tool, especially when weights are not excessive and structures are properly detailed as to splice locations." The requirements of efficient derrick cars are stated and references given to descriptions of cars of this type in engineering papers. It would seem that more might have been said, to advantage, on the deficiency of the derrick car in lateral stability, a defect which has been the cause of many accidents.

The article on "Preparation for Erection" contains some statements which seem to be not very well considered. It is not true that *all* "large railroad systems do not have work erected by contract, but have it done by their own forces," as might be understood; boat traffic is not discontinued in winter in *all* navigable streams; it is presuming a good deal to state unqualifiedly that "provision should be made in the contract for percentage payments, after material is delivered at the shop, after fabrication, after delivery at the site, after erection, and, finally, after completion of riveting and painting," etc.

The new chapter on "Highway Bridges" opens well with a general article on the classes of bridges and the kinds of loads to be provided for. Types of floors are described and illustrated, especially concrete floors for country highway bridges. Beam and truss construction, principally for country bridges, is described. Some examples of good pony truss designs are shown. Tables giving sizes and weights of beams and weights of truss bridges for various spans and with both plank and concrete floors, are included. Many details of construction are shown. Highway abutments of the cheaper types are described and illustrated, and some of their defects pointed out. An analysis of the elements of cost of bridges of certain types, with a table giving the average cost, per unit of weight, of these elements, taken from the records of a certain plant, is included and should be found useful as a guide in estimating. The chapter concludes with the detailed analysis of the design of a through, pin-connected, country highway span, having a concrete slab floor.

The reviewer must offer some rather severe criticism of this chapter. In general, it treats almost exclusively of the cheapest types of country bridges and of certain practices stated to be found in the States of Illinois and Iowa, with which the author is presumably in close touch; also, the author does not seem to be familiar with, or else must ignore, the practice in the more easterly sections of the United States, which is in many respects decidedly different and superior to that described. The treatment of types and practices frequently omits essential features and is often inaccurate. There is a lack of data and reasons for unusual conclusions and statements. Designs and details usually considered flimsy, crude or bad are advocated. Much space is given to unimportant details, tables of weights, etc., which might better be devoted to a broader treatment of the subject in general. The author makes himself the arbiter of good practice on many points on which there might well be difference of opinion.

The reader can, perhaps, pass on the justice of this criticism from the following: Plank floors are treated as a type now obsolete and the statement appears that "the majority of floors of country highway bridges are now built of concrete or reinforced concrete, with an earth cushion on top." (The reviewer would offer the statement that for country bridges in the states east of Illinois, the plank floor is the rule and the concrete floor the exception and will be for some time to come.) Sections of recommended concrete floors having a covering of earth from one to three inches deep and with exposed steel at the sides, are shown; regarding this type the naïve statement is made that "when the earth cushion becomes saturated with water, it is impossible to have heavy engines pass over it, since they would slip about too much to allow their successful operation"!

The assumption that the bending moment caused by a 15-ton traction engine with wheels spaced 5 ft. apart (c.c. of tires) on the floor joists of a 16-ft. clear roadway, is equally distributed over all the joists of the roadway, is not seriously questioned by the author (5-in. to 4-in. reinforced-concrete floor slab on joists spaced 2 ft. 8 in.); neither is the statement that the entire weight of such an engine can be properly treated "as a uniform load distributed over a space 12 ft. long by 7 ft. wide" on a 7-in. slab, with only longitudinal reinforcement, and no joists, spanning 10 ft. between floor beams. The author finally shows the steps in the proportioning of joists to carry a 6-in. floor, assuming each wheel load distributed equally over three joists

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spaced 2 ft. 8 in. Rod laterals for top, sway and portal bracing of through truss bridges with concrete floors are recommended, as are details which would only be proposed by the cheapest highway bridge companies. It is stated that "Riveted high trusses are seldom used for highway traffic," and their use for bridges with concrete floor is advised against, pin-connected trusses being recommended.

Only a feeble protest is made against the steel cylinder abutment with steel-plate wings, which is sometimes "worked off" on our country brethren. The use of ordinary bolts instead of rivets for field connections is stated to be allowable, provided 25 per cent. excess over the number theoretically required is used. In the analysis of design of the floor beams for the truss span considered, the span of the floor beam is taken equal to the clear roadway, with the explanatory statement that "the effective span is in reality somewhat greater, but since the difference is seldom more than 6 in., a length taken equal to the clear roadway will not make any material difference in the design."

The revision of the chapter on "Railroad Riveted Bridges" has the desired breadth of treatment and accuracy of statement. The development of the riveted type for increasing span lengths is noted. The analysis of design of a pony riveted truss span found in the preceding edition is omitted in the new edition, it being stated that it is now the general practice to eliminate this type, using the plate girder instead. Articles on the usual composition of the various classes of truss members, such as chords and posts, diagonals, etc., and on the usual widths of members, are new and contain valuable information for designers. A new Canadian practice in the use of web members with center (diaphragm) plates and no latticing is described and is illustrated by photographs of several new Canadian railroad bridges. The great variation in practice with respect to the thickness of connection plates is commented upon; an approximate method for the rational determination of the thickness of such plates is suggested.

Some of the general detail drawings for a new double-track, riveted-truss span of the New York Central & Hudson River R.R. over the New York State Barge Canal are reproduced in a plate. In this design an attempt was made to provide for the secondary stresses in the truss members, due to the deflection of the shallow floor beams under the specified loading. The angle bar latticing of the compression members is also unusual.

Some interesting data on the distribution of weight of material between main sections and various details of trusses and between the component parts of truss spans is given in an article on "analysis of weight." These data the reviewer would consider of value only as showing the range of variation found in practice. If the weights of the main sections had been determined by assuming their lengths to be equal to the distances between panel points, the results would possibly be of more practical value. Some of the comments on the results are valuable, as indicating how the percentage of details is affected by the type of truss and the composition of members. This chapter is illustrated by photographs of modern riveted truss spans of several American railroads, in addition to the Canadian spans previously mentioned, all of which are new in this edition.

The plates in the previous edition, showing the details of the Northern Pacific Ry. standard 90-ft. deck-plate girder span and 200-ft. pin-connected truss span, have been replaced with plates of similar details for the same railroad company's standard 80-ft. deck-plate girder and 160-ft. pin-connected truss span.

The reviewer has noted several points in the unrevised chapters that would appeal to him as subjects for revision. Among these may be noted the mention of obsolete handbooks of manufacturers; the retention of some figures showing obsolete standard details, especially small-diameter expansion rollers; the article on solid floors for plate girders; the specifications for compression members used for the design of a railroad pin-connected truss span, in the details of latticing, pin plates and ratios of thickness to width of unsupported legs and webs. As the more recent improvements in structural detailing have been largely applied to column details, the omission of revisions to keep step with this feature is to be regretted.

HISTORIC INVENTIONS—By Rupert S. Holland, Author of "Historic Boyhoods," "Historic Girlhoods," "Builders of United Italy," etc. Philadelphia: George W. Jacobs & Co., Cloth; 5½x8½ in.; pp. 295; many plates. $1.50, net.

The inventions given a place in this volume are the printing press, Palissy's enamel for pottery, the telescope, the steam engine, the spinning jenny, the cotton gin, the steamboat, the Davy safety lamp, the locomotive, the telegraph, the reaper, the sewing machine, the telephone, the electric light, the wireless telegraph and the Wright biplane. Of course, this is not a complete list of the inventions of historic importance, and not everyone will even agree that the most important inventions have been selected. Considering the stock of more important material available, it is hard to concede the author's plea that the story of Bernard Palissy is far too interesting to need any further excuse for giving it space.

The author's method is to narrate the life history of the inventor, in so far as it concerned the invention under consideration, and to describe the difficulties met in bringing it to a commercial success. In the case of the electric light, however, the story is more properly a biography of Mr. Edison and brings in a number of his other inventions.

The descriptions of the inventions themselves are from a popular rather than a technical viewpoint. In the title of the final chapter, "The Wrights and the Airship," a blunder appears that will be evident to many of the young people even, for whom the book was written. The mistakes that occur, however, are not of a sort to cause serious misunderstandings, and for this reason they are more than compensated by the author's clear and pleasant style.

FIRST INTERNATIONAL MUNICIPAL CONGRESS AND EXPOSITION. Held under the Auspices of the Chicago Association of Commerce, Chicago, Sept. 18-30, 1911. Chicago, Ill.: The Association (Howard Elting, Gen. Secy.). Paper; 7x10 in.; pp. 167.

Various papers on a wide range of municipal topics were submitted at this congress and are here presented in abstract. In a few instances, formal conclusions were reached by those taking part in special conferences. This was particularly the case in respect to the regulation of public milk supply. The type used is so small and closely set and the length of the line so long that we fear very few people will ever read the report, though it may nevertheless be useful for purposes of reference.

The study of "Organic Matter from the Expired Breath," contributed to the Journal of Medical Research, Vol. XXV, No. I (Sept., 1911), by Milton J. Rosenau and Harold L. Amoss, of the Department of Preventive Medicine and Hygiene, Harvard University, Cambridge, Mass., has been reprinted for circulation by the authors. After reviewing earlier studies of the subject, which left the question in confusion, the authors describe their own experiments and set forth, by means of numerous tables, the results obtained. The experiments consisted in condensing vapors from the expired breath of a man and injecting the liquid into guinea pigs, subsequently testing the guinea pigs to determine whether they had become "hypersusceptible" to normal human blood. The test was based on the very delicate nature of the reaction of anaphylaxis. The authors believe that they have for the first time demonstrated "that the expired breath contains organic matter, and that this organic matter is specific in nature." They believe this finding will "have an immediate bearing upon the problem of ventilation and the effect of vitiated air." Further studies, the authors add, are needed to prove whether or not the organic substances in the expired breath are poisonous.

A New Edition of Lorenz's Theory of Turbines

Reviewed by LEWIS F. MOODY*

NEUE THEORIE UND BERECHNUNG DER KREISELRAEDER — Wasser- und Dampfturbinen, Schleuderpumpen und Geblase, Turbokompressoren Schraubengeblase und Schiffspropeller. Von Dr. Hans Lorenz, Professor der Mechanik an der Techn. Hochschule zu Danzig. Zweite, neubearbeitete und vermehrte Auflage. Munich and Berlin: Druck und Verlag von R. Oldenbourg. Cloth, 6½x9½ in.; pp. 240; 116 text illustrations. Marks, 12; American price, $4.80, net.

This work, the first edition of which was published in 1906, and was reviewed in these columns by the late Prof. Storm Bull (Eng. Lit., p. 87, Jan. 17, 1907), is one of the most remarkable contributions to the subject of hydraulics which has appeared in many years. Its author dedicated it "To the memory of that great Mathematician Leonhard Euler, the Founder of Hydrodynamics and the Theory of the Turbine"; and the idea which gave rise to the book was the thought of applying the modern mathematical theory of hydromechanics to practical hydraulic problems. Dr. Lorenz has written a number of text-books on thermodynamics, mechanics, etc., and one of these treatises, entitled "Technical Hydromechanics," covers the field of general hydraulics. In presenting that work Dr. Lorenz stated:

> In the above mentioned book it has been sought to bridge over as far as possible the separation between Theoretical Hydromechanics and the almost entirely empirical Hydraulics. For this purpose there serves, on the one hand, a more exact formulation of the Bernoullian stream-filament theory, considered up to the present only in Hydraulics, taking into account the resistances to motion and lateral oscillations; and on the other hand, a presentation, limited to a practical and elementary treatment, of the fundamental laws of Hydromechanics, applied to such problems as remain difficult of solution by hydraulic treatment.

The first problems to which Dr. Lorenz applied the methods described in the above quotation were those connected with machines involving the turbine principle—included under the generic term "Kreiselräder" or "rotating wheels"—and comprising motors and pumps for water, steam, and air. He had presented a number of papers on subjects related to these problems, and had developed a "theory" or method of treatment which seemed to promise important and valuable results when applied to practical problems of design. A systematic treatment of the subject formed the material of the first edition of the book under discussion; the same methods have since been applied by their author to a broader field, as already mentioned; and in the present edition of this book we find various new problems worked out in the same manner.

It may be stated at once, to clear up misconceptions, that the methods which Dr. Lorenz has originated for attacking hydraulic problems are more interesting and probably more valuable than the results so far obtained. Without the use of his methods the efficiencies of modern turbines and centrifugal pumps have been carried to such a high point that little further advance is now possible; and it is also important to note that the assumptions which he has been obliged to make, to render the problems of the waterwheel and pump sufficiently simple to be capable of treatment by his theory, make it impossible to increase the capacity or speed of such machines. Since, therefore, no promise of development in capacity or "specific speed" is offered, and but little increase in efficiency is possible, very little can be hoped for, when considering the two classes of machines mentioned. Greater possibilities are open in the direction of steam turbines, turbocompressors, and fans and screw propellers. In the case of the last mentioned problem, some of the assumptions have been attacked in the German technical press, and are open to doubt; and indeed the whole "New Theory," involving as it does a radically new mode of development, has been subjected to much discussion and criticism in Germany.

For the reasons just stated, and because the work does not exist in translation, it is to be feared that American engineers will be slow to undertake the study of this book. This is unfortunate, because the subject of hydraulics is in need of some such general methods as the book offers.

To those who are inclined to judge everything from the standpoint of practical utility, few definite results can be offered up to the present. Tests on turbines built according to the Lorenz design have shown poor results; while Lorenz centrifugal pumps have given in two cases efficiencies of 76 and 81%, which reflect great credit on their designers, and argue well for the utility of the theory. The present edition contains accounts of a number of tests.

The development of the theory, though utilizing differential equations to a considerable extent, and calling for a good working knowledge of calculus, is not difficult to follow in its general applications, the mathematical portions being clearly presented. The points which are open to more or less question arise in the application of the theory to particular problems, such as the design of the turbine runner, or the screw propeller.

The author states that the present type of high-speed waterwheel which has reached so high a development in this country, is of too complicated a form to be treated by his methods, without great mathematical complexity. For this reason he has limited the discussion to runners having wheel vanes shaped as cylindrical surfaces with elements parallel to the shaft, a form which has not shown high efficiency in practice. It may be fairly stated, however, that the high-speed turbine involves great difficulty in treatment by *any* theory.

The theory has, on the other hand, been of great use in considering the proper forms for waterways at various points in hydraulic systems—such as the turbine draft tube, for instance. The writer has recently had the opportunity to test a draft tube designed according to this theory (a form of tube first developed by Prázil)—the results being extremely satisfactory.

The second edition includes some new matter of interest. One point which may be mentioned is a rational form of pipe-bend. Instead of designing a bend with circular cross-section and with its center line a circular arc, as is the universal practice at present, the Lorenz form consists of an oval cross-section, the section in the plane of the bend consisting of hyperbolæ gradually approaching the straight run of the pipe on either side. This form results from the provision for flow free from eddies, which is one of the basic conditions introduced in the general theory.

One of the most valuable results of the publication of Dr. Lorenz's work has been the extended discussion called out by it, and the stimulation of development and extension of the work by other German writers. The second edition gives much space to these discussions, which have added to the value of the original work; and in this edition the author has endeavored to clear up all doubtful points. With this object in view he has rewritten some of the passages which have appeared to involve some obscurity.

In conclusion, it may be said that this is only one of a remarkable succession of valuable and important German technical works published within the last few years, and it is greatly to be desired that a number of these works should be made available to those American engineers who lack a reading knowledge of German. It is hoped that this book may be one of those added to the small list of translations now existing.

Three pamphlets dealing with land drainage have been issued by the U. S. Department of Agriculture. Two of them are reprinted from the Annual Report of the Office of Experiment Stations for the year ending June 30, 1910, one being entitled "Development of Methods of Draining Irrigated Lands," by C. G. Elliott, Chief of Drainage Investigations, and the other, "Work of Drainage Investigations, 1909-1910," by R. D. Marsden, Office Engineer, Drainage Investigations. The third pamphlet, on "Land Drainage by Means of Pumps," is by S. M. Woodward, and was prepared under the direction of Mr. Elliott. It contains a considerable amount of descriptive matter relating to work carried out.

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The Port of Hamburg

THE PORT OF HAMBURG—By Edwin J. Clapp, Author of "The Navigable Rhine." New Haven, Conn.: Yale University Press. London: Henry Frowde, Oxford University Press. Cloth: 5¼x8 in.; pp. 220; two maps (one folding) and many photographic plates. $1.50, net; postage, 16c.

The growing recognition of the desirability of improving American ports makes books of this class of general interest, and they may be "accepted as information" (to use a phrase frequently applied in relation to reports of technical societies), although their information is not directly applicable to American conditions. The author states his opinion that "the much-needed modernization of our ocean and Great Lakes terminals must be along the lines followed in Hamburg," but we fail to see that his book gives any information in support of that statement. A far-sighted and broad-minded administration combined with the provision of ample dock frontage and freight-handling machinery are not peculiar to any one European port.

The low tidal range at Hamburg makes it unnecessary to provide the closed docks necessary at many European ports, but the physical conditions are not those of American ports. Hamburg is on a narrow river, and ships are accommodated in several large basins dredged out of the land, each basin holding a number of vessels. At most of the large American ports there is ample water area, and this is utilized mainly by the construction of piers, each of which accommodates one steamer on each side.

One important feature in the development of the port of Hamburg is its system of administration, and information in regard to this would be of considerable value, as this is a weak point in most American ports. But unfortunately the author does not discuss this subject. Indeed a large part of the book relates to the commerce and shipping of Hamburg, a subject which may be of interest in itself, but which has no particular bearing upon the general subject of port improvements.

Hamburg is one of the great ports of Europe, and has attained and held this position in spite of the fact that it is 85 miles from the sea, and is on a river (the Elbe) whose channel depth in the '40s was but 6½ ft. at low water and 13 ft. at high water. In view of the enormous and increasing cost of enlarging the channel to meet the requirements of ocean steamers, it was proposed at one time to make the river-mouth town of Cuxhaven the main port. But commercial considerations soon showed this to be undesirable and uneconomical, and all energies have been centered upon the improvement of the port proper and its river approach. The present channel is 650 ft. wide, with a depth of 26¼ ft. at low water and this is being increased to 33 ft. With a tidal range of only 6½ ft. no inclosed docks are required, and the accommodation for shipping comprises a number of interconnetced basins, separated by piers formed of the solid ground left between the various excavations. An interesting feature is that Hamburg is a "free port," with no import or export duties, and consequently no interference or delay due to supervision and control by customs officers. The customs duties are due only when inbound goods leave the port; then they come under the jurisdiction of the German custom house (unless forwarded in bond).

The two subjects which are of particular interest are: (1) The improvement of the 85-mile channel to the sea, and (2) the port facilities. A third subject which is of interest in itself and also in relation to the inland-waterway movement in this country is that of inland communication, and one chapter deals with the railway connections and the extensive system of inland navigation (comprising rivers and canals) which is tributary to the port of Hamburg. On this point the author expresses the opinion that "river transportation in America, if it is ever to be resuscitated, must be modeled on that of the great German streams, the Elbe and the Rhine." By way of comparison, illustrations are given to show river ports on the Elbe (with proper wharf facilities and freight-handling equipment) and Mississippi River landings, with the familiar crude facilities. No attempt is made to draw comparisons, however, but the description of German inland navigation and inland ports certainly makes interesting reading.

Other subjects covered by the book include a review of the over-sea and inland commerce of Hamburg, the growth of the principal German steamship lines using the port, and the development of shipbuilding, shipping and mercantile interests. The whole book is interesting, but mainly as showing how certain things have been done abroad in one particular instance. In fact, the author disclaims any intent to prescribe what should be done in this country, stating that his work is "an investigation, not a program or a prophesy."

COMPETITIVE AND MONOPOLY PRICE. A Criticism of Current Theory with Special Reference to its Bearing upon the Trust Problem. By Frederick Charles Hicks, University of Cincinnati. Cincinnati, Ohio: The University. Paper; 6x9 in.; pp. 39. 40c., net.

After reviewing the basis of the present trust policy and the theory and practice of prices under both competition and monopoly conditions, the author briefly outlines "A Trust Policy Fair to Big Business and to the Consumer." In a nutshell, this consists of "the proper balancing of competition and of unity of action, the former insuring fairness to the consumer, the latter insuring fairness to the producer." The discussion is free from technicalities and readable throughout.

MICROBIOLOGY—For Agricultural and Domestic Science Students. Edited by Charles E. Marshall, East Lansing, Mich., Professor of Bacteriology and Hygiene, Michigan Agricultural College. Philadelphia, Penn.: P. Blackiston's Son & Co. Cloth, 5x8 in.; pp. 724; 128 illustrations. $2.50, net.

This book aims to cover, "besides the bacterial forms, those microörganisms yielding to the same laboratory methods of study and investigation." The plan and scope include (I) the morphology and culture and (II) the physiology of microörganisms, besides (III) the wide-ranging field of applied microbiology. Under Part I, molds, yeasts, bacteria, invisible microörganisms and protozoa are treated. Part II takes up nutrition and metabolism, the food of the microörganisms, and both the products and mechanism of metabolism, also the physical and chemical influences to which microörganisms are subject. These topics occupy 187 pages of the book, thus leaving some 520 pages for Part III, and about 20 pages to the separate index of organisms and the unusually full general index.

A detailed enumeration of the contents of Part III, Applied Microbiology, would fill several columns. The main topics are air, water, sewage, soil, milk and its products; special industries, including food preservation, the manufacture of vinegar, beer, etc., and vaccines; diseases of plants; and diseases of animals and man, including infection, immunity and susceptibility, as well as reviewing so many separate diseases as to make one marvel that human and animal life has withstood thus long the attacks of so many enemies. The final chapter, "Control of Infectious Diseases," is by H. W. Hill, director, Epidemiological Division, Minnesota State Board of Health. Prof. Earle B. Phelps, of Boston and New York, contributed the chapter dealing with sewage.

Speaking from the viewpoint of the sanitary engineer who wishes to have on his shelves a small reference book on industrial and sanitary microbiology, the volume promises to be as useful as it is handy.

THE MANKATO TYPHOID FEVER EPIDEMIC OF 1908. By H. M. Bracken, F. H. Bass, F. F. Wesbrook, H. A. Whittaker and H. W. Hill. Reprinted from the "Journal of Infectious Diseases" [Chicago], November, 1911. St. Paul, Minn.: The Authors, c/o State Board of Health. Paper; 6¾x9½ in.; pp. 64; illustrated.

The more strictly engineering features of the very interesting water-borne outbreak of typhoid fever at Mankato, Minn., which occurred in 1908, were described at some length in ENGINEERING NEWS, of Oct. 5, 1911, p. 406.

The pamphlet before us consists of a general account of the outbreak by Dr. Bracken, secretary of the Minnesota State Board of Health; a presentation of "The

Engineering Data," by Prof. F. H. Bass, director of the Division of Engineering; "The Laboratory Data," by Messrs. Wesbrook and Whittaker, and "The Epidemiological Data," by Dr. H. W. Hill, director of the Division of Epiodemiology of the board named. Dr. Hill's discussion promises to be of particular value to engineers who have occasion to investigate typhoid outbreaks. He gives useful data bearing on the determination of the date of the incidence of the disease and shows how misleading it is to rely merely upon the date on which the physician was called in.

How to Get Sunlight

THE ORIENTATION OF BUILDINGS, or Planning for Sunlight. By William Atkinson, Fellow of the Boston Society of Architects. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth, 5¾x9¼ in.; pp. 139; 74 text illustrations. $2, net. (8/6, net.)

It would be hard to name a highly specialized subject on which a monograph would be more acceptable than the relation between the orientation of buildings and of streets. But little information on the subject is available; at least not in English—the Germans may have covered it more or less thoroughly. The subject is an important one where there is a range of choice as to orientation, as frequently happens in the location of institutional buildings, particularly hospitals, in the open or comparatively open country. It is also of great importance in the laying out of new towns and town or city additions, since in cities it is the orientation of streets which governs the orientation of buildings, except as to choice between the side of the street on which a building is located, and as to the placing of buildings on large lots. As to the latter, there is usually but little choice, except as to main frontages or corner lots or whole blocks; and save for those who are willing to defy conventionalities and place the axes of buildings at oblique angles to the streets.

Mr. Atkinson opens his book with a presentation of the elementary astronomical data needed to understand the motions of the sun and the variations of the angle of sunlight at different seasons of the year. The principles of stereographic projection are explained. He next shows the distribution of sunlight on the exterior of buildings and through their windows, making use of "shadow curves" and "areas of complete shadow," an application of descriptive geometry which he thinks is new. A chapter is devoted to hospitals and another to the distribution of sunlight in streets, as affected by the direction and width of the streets and the height of buildings fronting on them. An appendix gives in full the regulations of the city of Paris governing the height of buildings and a synopsis of the comparatively meager corresponding regulations of a few American cities.

Mr. Atkinson's numerous diagrams, and particularly those showing shadows cast by buildings hour by hour and portions of buildings in shade at various times of the day or constantly, strike us as unique and as of great practical value for either direct use or as a guide to making similar diagrams for other latitudes than the one used by him, 42° 0'. Particularly suggestive to some of our readers would be the diagrams showing the exclusion of sunlight from streets lined with tall buildings.

It should be understand that while the author believes in the value of sunlight, he leaves the discussion of that phase of subject mostly to others. He refers those interested in the therapeutic valley of sunlight to "Luft-und Sonnenbäder," by Julian Marcuse (Stuttgart, 1907).

Finally, without meaning to detract one whit from the value of Mr. Atkinson's unique and interesting book, we would call attention to the fact that those called upon to take up the broader relations of the orientation of buildings and of streets might possibly find some conflict between the demands for sunlight and for what we believe the Germans call town ventilation. This demands the planning of streets and buildings with regard to the direction of prevailing winds; either to assist or to retard air movements. Topography, too, may be an important factor in orientation, particularly of streets. No one can seriously blame Mr. Atkinson for having confined himself strictly to his chosen subject, which he seems to have covered most admirably.

ASSETS AND LIABILITIES OF THE NEW YORK, NEW HAVEN & HARTFORD RAILROAD COMPANY —Report of the Board of Railroad Commissioners, the Tax Commissioner and the Bank Commissioner, Sitting as a Commission (W. P. Hall, Chairman), Feb. 15, 1911. Boston, Mass.: Pub. Doc. Cloth; 5½x9 in.; pp. 581; two folding maps and two folding charts.

One of the most notable tasks in the valuation of a railroad property ever undertaken in this country is described in this report.

In 1908, the attorney-general of the State of Massachusetts announced that the New York, New Haven & Hartford R.R. Co. had rendered itself liable to forfeiture of its charter in Massachusetts through having made a large increase in its capital stock without obtaining previous permission of the Massachusetts authorities, as required by the laws of that state. Other facts were also specified whereby the company had rendered itself liable to forfeiture of its charter.

Under these circumstances, the Legislature of 1910 passed an act creating a commission to examine the property of the New York, New Haven & Hartford R.R. to ascertain "Whether and to what extent the aggregate corporate assets of said corporation are sufficient to secure its outstanding capital stock and indebtedness." This commission was made up of the Board of Railroad Commissioners of the State, the State Tax Commissioner and the State Bank Commissioner. The actual work of valuation was placed in the hands of Prof. George F. Swain, as Chief Engineer, and under his direction a force of experts were made up, including among its members Mr. August Mordecai, Mr. Herschel Roberts, Mr. George S. Hubbell, Mr. A. F. Proctor, Mr. T. B. Purves, Jr., Mr. Azel Ames, Mr. G. F. Wells and Mr. James Donald.

The report presents in much detail the methods adopted in making the valuation of the property, and compares the methods used with the methods adopted in the railway appraisal carried out by Michigan, Wisconsin and Minnesota. In carrying out the work, large use was made of a previous physical valuation of the property, made by Mr. John F. Stevens, while Vice-President of the New Haven company.

A very interesting feature of the volume, and one which makes it especially worthy of inclusion in any engineering reference library, is a complete report prepared by Mr. Arthur H. Weed on the history of the New York, New Haven & Hartford R.R. Co., and of the multitude of smaller railway and other corporations which it has absorbed in the course of its existence. This report is, in fact, a summary of the railway history of southern New England.

THE KINGDOM OF DUST. By J. Gordon Ogden, Ph. D.; Professor of Physics and Chemistry, Fifth Avenue High School, Pittsburg. Chicago, Ill.: Popular Mechanics Co. Cloth; 5x7 in.; pp. 116; illustrated. 50c., net.

Dust is here used to cover a multitude of the smaller moving or readily moving substances which float above and lodge upon the surface of the earth or, being deposited on the water, find their way to the ooze beds below. Molds and bacteria are brought within the scope of the book and with them some account of the relation of dust to occupational and infectious diseases. The book shows no particular plan or object other than the presentation of information on its chosen subject in a popular manner, but with an apparent desire to be scientifically accurate in detail and in the general pictures drawn for the delectation of the popular mind.

THE REPORT OF THE PHILADELPHIA MILK SHOW. Its Organization and Management and a Description of the Exhibits. Edited by Arthur Edwin Frost. Bureau of Municipal Research; Executive Secretary, Philadelphia Milk Show. Philadelphia, Penn.: The Executive Committee. Paper; 7x10 in.; pp. 123; illustrated.

A full account of the origin of this milk exhibit, of its publicity matter, and of the exhibits themselves, is here presented. The motto adopted by the promoters was "To Enlighten, Not to Frighten."

New Edition of Stoughton's Iron and Steel

Reviewed by JOSEPH W. RICHARDS, PH. D.*

THE METALLURGY OF IRON AND STEEL—By Bradley Stoughton, Ph. D., B. S. Second edition, thoroughly revised. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. 537; 370 illustrations in text; 57 tables. $3, net.

At the price, this is the best book on this subject in the English language. The descriptions are lucid, well illustrated, and brought very well up to date; different parts of the treatment are well balanced; theories put forward are those generally accepted by metallurgists, and if wrong the author is not to be blamed. The book is throughout readable and easily understood; will be useful to students of engineering taking a short course in metallurgy, to engineers as a work of reference, to workmen in metallurgical plants, to teach them the principles of the subject. Professional metallurgists may find it occasionally useful as an *aide memoire;* they will find in it some few slips, especially on the theoretical side, but for the main practical purposes of the book, as above defined, these are disappearingly small.

HAND-FORGING and WROUGHT-IRON ORNAMENTAL WORK—By Thomas Googerty. Chicago, Ill.: Popular Mechanics Co. Cloth; 5½x8 in.; pp. 197; 122 text illustrations. $1, net.

The chief use for this book would seem to be as a textbook for manual-training schools where instruction in ornamental iron forging is given. The introductory chapter gives brief instruction in the principles to be observed in designing ornamental iron work. Following this there is a chapter on equipment of the forge shop and three chapters on welding and other forging processes. The last seven chapters deal entirely with ornamental iron work and the methods of producing twists, scroll work, embossed work, etc. While the chapters on welding and plain forge work are good as far as they go, the book is hardly suitable as a text for a shop course in engineering schools. No information is given on the methods of manufacturing wrought iron and steel, nor on their chemical composition.

NOTES ON HEATING AND VENTILATION. By John R. Allen, Professor of Mechanical Engineering, University of Michigan; M. Am. Soc. H. & V. E.; M. Am. Soc. M. E.; M. Am. Soc. Prom. Eng. Ed. Third edition. Chicago, Ill.: Domestic Engineering Co. (443 So. Dearborn St.). Cloth; 5½x8¾ in.; pp. 227; 224 text figures. $2.50, net.

The first edition of this book was briefly and favorably noted in our issue of Mar. 15, 1911. The value of the book has been increased by re-writing and expansion, "with a view to making the book more desirable as a college text."

*Professor of Metallurgy, Lehigh University, So. Bethlehem, Penn.

PUBLICATIONS RECEIVED

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. The amount of postage necessary can be estimated approximately from the stated size of the book or pamphlet and the number of pages it contains. Reprints of papers read before engineering societies and printed by the authors for private circulation can often be obtained without cost by addressing the author, whose name and address is always given when known. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of a reprint of a society paper to the author of the paper. The stated American prices of foreign books are based on 40 cents per shilling and per mark for British and German books, respectively, and 30 cents per franc for French books, the extra allowances being for importation costs.]

AGRICULTURAL OBSERVATIONS ON THE TRUCKEE-CARSON IRRIGATION PROJECT—By F. B. Headley, Assistant Agriculturist, and Vincent Fulkerson, Agent. Circular No. 78—Bureau of Plant Industry, U. S. Department of Agriculture. Washington, D. C.: Pub. Doc. Paper; 6x9 in.; pp. 16.

THE AMERICAN GOVERNMENT — By Frederic J. Haskin. Philadelphia and London: J. B. Lippincott Co. Cloth; 5x8 in.; pp. 398; 24 illustrations. $1,

AMERICAN NEWSPAPER ANNUAL AND DIRECTORY—A Catalog of American Newspapers. A Description of Every Place in the United States and Canada. Philadelphia, Penn.: N. W. Ayer & Son. Cloth; 6½x10 in.; pp. 1414; maps. $5, net; postage, 60c.

THE AMERICAN TRANSPORTATION QUESTION—By Samuel O. Dunn, Editor of "The Railway Age Gazette"; Lecturer on Transportation at Northwestern University; Member of the Illinois Bar. New York and London: D. Appleton & Co. Cloth; 5x7½ in.; pp. 290. $1.50, net.

ASSOCIATION OF TRANSPORTATION AND CAR ACCOUNTING OFFICERS —Proceedings of the Louisville, Ky., meeting, December, 1911. (Secretary: G. P. Conrad, 75 Church St., New York City.) Paper; 5½x8½ in.; pp. 245.

BOARD OF HARBOR AND LAND COMMISSIONERS [Massachusetts]—Annual Report for 1911. Boston, Mass.: Pub. Doc. No. 11. Paper; 6x9 in.; pp. 106; four folding maps.

BRICK MANUFACTURE AND BRICKLAYING—References to Books and Magazine Articles. Reprinted from the Monthly Bulletin, Carnegie Library of Pittsburg, January, 1912. Pittsburg, Penn.: The Library. Paper; 6x9 in.; pp. 33.

BULLETINS, U. S. GEOLOGICAL SURVEY—Geo. Otis Smith, Director. Washington, D. C.: Pub. Doc. Paper; 6x9 in.

No. 393: Incidental Problems in Gas-Producer Tests. By R. H. Fernald and others. Pp. 29; eight text figures.

No. 494: The New Madrid Earthquake. By Myron L. Fuller. Pp. 119; 10 plates and 18 text figures.

No. 496: Results of Triangulation and Primary Traverse, for the Years 1909 and 1910. By R. B. Marshall, Chief Geographer. Pp. 392; two plates (one folding map).

No. 512: Potash-Bearing Rocks of the Leucite Hills, Sweetwater County, Wyoming. By Alfred R. Schultz and Whitman Cross. Pp. 39; folding plate (map) and nine text figures.

THE CHANGING CHINESE—The Conflict of Oriental and Western Cultures in China. By Edward Alsworth Ross, Ph. D., LL. D.; Professor of Sociology in the University of Wisconsin. Author of "Social Control," "Foundations of Sociology," "Social Psychology," etc. New York: The Century Co. Cloth; 5½x8½ in.; pp. 356; 88 text illustrations. $2.40, net.

THE CHEMICAL PRINCIPLES INVOLVED IN SEWAGE DISPOSAL—Being a paper read before the Canadian Public Health Association at Montreal, December, 1911. By George G. Nasmith, Ph. D., Director of Laboratories of the Health Department, Toronto. Reprinted from "The Public Health Journal." Paper; 7x10¼ in.; pp. 4. Address The Author.

THE DES MOINES WATER SUPPLY AND THE PUBLIC HEALTH—By Robert N. Kinnaird, B. S. in C. E., Sanitary Engineer for the Des Moines Water Co. An Address to the Polk County Medical Association, Des Moines, Ia., Jan. 30, 1912. Paper; 6x9 in.; pp. 16; illustrated. Address the author.

EISENBAHNBAU, TUNNELBAU, STADT- UND UNTERGRUNDBAHNEN, BERGBAU—Being Part VII of the "Handbuch für Eisenbetonbau." Second new and enlarged edition. Herausgegeben Dr. Ing. F. von Emperger, K. K. Oberbaurat, Regierungsrat im K. K. Patentamt in Wien Containing papers prepared by E. Homann, J. Labes, R. Basteau, A. Nowak, B. Nast. Berlin: Wilhelm Ernst & Sohn. Paper; 7¾x10½ in.; pp. 511; 1093 text illustrations. Marks 21; cloth, M. 24; American price, $8.40 and $9.60, net.

EISENBETON-SCHAULINIEN—Für Eine Unmittelbare Dimensionierung Einfach und Ideal Bewehrter Tragkonstruktionen (Nebst Einer Erläuterung). By Ing. Karl Allitsch, K. K. Professor in Innsbruck. Wien: Druckerei-und Verlags-Aktiengesellschaft. Paper; 7x10½ in.; pp. 23; six plates and 7 text illustrations.

ELECTRIC IGNITION FOR COMBUSTION MOTORS—By Forrest R. Jones, M. E.; M. Am. Soc. M. E. and Soc. Prom. Eng. Ed.; formerly Professor of Mechanic Arts, University of Tennessee, etc. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5¾x9¼ in.; pp. xii + 438; 294 text figures. $4, net (17/- net).

THE ELEMENTS OF STRUCTURES—Prepared in the Extension Division of the University of Wisconsin. By Geo. A. Hool, S. B., Assistant Professor of Structural Engineering, The University of Wisconsin. New York and London: McGraw-Hill Book Co. Cloth; 6x9½ in.; pp. 188; almost 200 text illustrations. $1.75, net.

ENGINEERING DIRECTORY — Edition of 1912. Chicago, Ill.: The Crawford Publishing Co. (537 So. Dearborn St.) Stiff leather; 4x6¾ in.; pp. 1496. $5, net.

ENGINEERING SOCIETY OF WISCONSIN—Proceedings of the Annual Meeting at Madison, Wis., March 8-10, 1911. Madison, Wis.: The Society (Jno. C. White, Secy.) Paper; 6x9 in.; pp. 296; illustrated. 50c.,

FARMERS OF FORTY CENTURIES—Or Permanent Agriculture in China, Korea and Japan. By F. H. King, D. Sc.; formerly Professor of Agricultural Physics in the University of Wisconsin, and Chief of Division of Soil Management, U. S. Department of Agriculture. Author of "The Soil," "Irrigation and Drainage," "Physics of Agriculture," etc. Madison, Wis.: Mrs. F. H. King. Cloth; 5½x7¾ in.; pp. 441; 248 text illustrations. $2.50, net.

THE GAS WORKS DIRECTORY AND STATISTICS, 1911-12—(Revised to August, 1911.) With a list of Chairmen, Managers, Engineers and Secretaries, and lists of Associations of Engineers and Managers. London: Hazell, Watson & Viney, Ltd., 52, Long Acre, W. C. Cloth; 5½x8½ in.; pp. lxviii + 491. 10/6, net; American price, $4.25, net.

GRUNDLAGEN DER ZUGFOERDERUNG Beim Elektrischen Betriebe der k.k. österreichischen Staatsbahnen. By Dr. techn. Artur Hruschka, k.k. Baurat. Sonderabdruck aus "Elektrische Kraftbetriebe und Bahnen" 1910, Heft 25-30. Munich: R. Oldenbourg. Paper; 9½x12½ in.; pp. 36; 32 text illustrations. Marks 1.50, net; American price, 60c., net.

ILLINOIS STATE MINING BOARD, 1911 —Annual Coal Report. Springfield, Ill.: Pub. Doc., Martin Bolt, Chief Clerk. Cloth; 5¾x8¾ in.; pp. 445.

ILLUMINATION—Its Distribution and Measurement. By Alexander Pelham Trotter. London: Macmillan & Co., Ltd. [New York: The Macmil-

lan Co.] Cloth; 5½x9 in.; pp. 292; 210 text illustrations; tables. $2.75, net (8/6, net).

INDIANA SANITARY AND WATER SUPPLY ASSOCIATION — Proceedings of the Annual Convention, held at Indianapolis, Feb. 9-10, 1911. Indianapolis, Ind.: The Association (Dr. W. F. King, Secy.) Paper; 6x9 in.; pp. 166.

INDUCTANCE OF COILS—By Morgan Brooks and H. M. Turner. Bulletin No. 53, Engineering Experiment Station, University of Illinois. Urbana, Ill.: The University. Paper; 6x9 in.; pp. 72; 25 text illustrations. 40c., net.

INDUSTRIAL OPPORTUNITIES — Part II, 16th Biennial Report, Bureau of Labor Statistics, 1910, State of Illinois; David Ross, Secy. Springfield, Ill.: Pub. Doc. Paper; 6x9 in.; pp. 171.

INVESTIGATIONS OF EXPLOSIVES USED IN COAL MINES—By Clarence Hall and others. Bulletin No. 15, Bureau of Mines; Joseph A. Holmes, Director. Washington, D. C.: Pub. Doc. Paper; 5¾x9¼ in.; pp. 197; seven plates and 5 text figures.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE—Vol. LXXXIV. Edited by Geo. C. Lloyd, Secretary. London: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Sold also at the Offices of the Institute, 28 Victoria St., London, S. W. Cloth; 5½x8¾ in.; pp. 731; 20 plates and many text illustrations. $6, net (16/, net).

DIE KRANKHEITEN DES STATIONAEREN ELEKTRISCHEN BLEIAKKUMULATORS, IHRE ENTSTEHUNG, FESTSTELLUNG, BESEITIGUNG, VERHUETUNG—Für Batterie besitzer, Betriebsleiter, Maschinenmeister und Installateure. By F. E. Kretzschmar. Munich and Berlin: R. Oldenbourg. Cloth; 5½x8½ in.; pp. 162; 83 text illustrations. Marks, 6, net; American price, $2.40, net.

A LABORATORY MANUAL OF PHYSICS AND APPLIED ELECTRICITY—Arranged and edited by Edward L. Nichols, Professor of Physics in Cornell University. In two volumes. Vol. I.—Junior Course in General Physics. Revised and rewritten by Ernest Blaker, Assistant Professor of Physics in Cornell University. New York: The Macmillan Co. Cloth; 5¾x9 in.; pp. 417; 135 text figures; tables. $3, net.

THE MEASUREMENT OF HIGH TEMPERATURES—By G. K. Burgess, Bureau of Standards; and H. LeChatelier, Membre de l'Institut. Third edition, rewritten and enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. 510; 178 text figures. $4, net (17/- net).

MECHANICAL STRESSES IN TRANSMISSION LINES—By A. Guell. Bulletin No. 54, University of Illinois, Engineering Experiment Station. Urbana, Ill.: The University. Paper; 6x9 in.; pp. 31; 10 text figures; five tables. 20c., net.

MECHANICS OF HEATING AND VENTILATING—With Charts for Calculation and Examples. By Konrad Meier, Consulting Mechanical Engineer for Heating and Ventilating. New York and London: McGraw-Hill Book Co. Cloth; 6x9½ in.; pp. ix-161; 36 text figures. $5, net.

MINERAL RESOURCES OF THE UNITED STATES, 1910—Part I: Metals. Part II: Nonmetals. Washington, D. C.: Pub. Doc. U. S. Geological Survey; Geo. Otis Smith, Director. Cloth; 5¾x9¼ in.; pp. 796 and 1005; many maps, plates and text illustrations.

NATIONAL IRRIGATION CONGRESS—Official Proceedings of the Nineteenth [Congress] Held at Chicago, Ill., Dec. 5-9, 1911. Edited by Arthur Hooker [Secretary]; Satterlee and Binns, Official Reporters. Chicago, Ill.: R. R. Donnelley & Sons Co. Paper; 6x9 in.; pp. 359.

NAVY YEARBOOK—Compilation of Annual Naval Appropriation Laws from 1883 to 1911; also Statistics of Foreign Navies. Founded by Pitman Pulsifer; Edited by Woodbury Pulsifer. Washington, D. C.: Pub. Doc. No. 112. Cloth; 6x9¼ in.; pp. 807.

OBSERVATIONS UPON THE NATURAL HISTORY OF EPIDEMIC DIARRHOEA—By O. H. Peters, M. D., D. P. H. Cambridge [England]: The University Press. [New York: G. P. Putnam's Sons.] Cloth; 7x10¼ in.; pp. 177; eight charts; 27 tables. 7/- net; American price, $2.80, net.

THE PARK GOVERNMENTS OF CHICAGO—General Summary and Conclusions of a Report Prepared by the Chicago Bureau of Public Efficiency, 315 Plymouth Court, December, 1911. (Geo. C. Sikes, Secy.) Paper; 6x9 in.; pp. 16; two folding plates. [Free upon request.]

A PRACTICAL MANUAL OF STEAM AND HOT-WATER HEATING—By Edward Richmond Pierce. Chicago, Ill.: Domestic Engineering Co. Cloth; 5½x8¾ in.; pp. 339; 30 text illustrations. $2.50, net.

PRACTICAL METHODS OF DISINFECTING STABLES—By George W. Pope, D. V. S., Veterinary Inspector, Quarantine Division, Bureau of Animal Industry, U. S. Dept. of Agriculture. Farmers' Bulletin 480. Washington, D. C.: Pub. Doc. Paper; 6x9 in.; pp. 16; illustrated.

THE PRECISE AND THEREFORE ECONOMIC CALCULATION OF PIPE DRAIN AND SEWER DIMENSIONS FOR USE IN WATER SUPPLY, DRAINAGE, etc.—By C. E. Housden, Late Superintending Engineer, Public Works Department, India; and Sanitary Engineer to the Governments of Burma and Eastern Bengal and Assam. New York, London, Bombay and Calcutta: Longmans, Green & Co Cloth; 5x7½ in.; pp. 53; illustrated. $1, net.

PROFITS AND WAGES IN THE BRITISH COAL TRADE (1898 to 1910)—By Thomas Richardson, M. P., and John A. Walbank, F. C. A. Newcastle-on-Tyne [England]: W. H. Robinson. 6d., net; postpaid, 7d. American price, 25c., net.

PROGRESS REPORT ON WOOD-PAVING EXPERIMENTS IN MINNEAPOLIS—By Francis M. Bond, In Charge Section of Wood Preservation, Forest Products Laboratory. Forest Service—Circular 194; Henry S. Graves, Forester. Washington, D. C.: Pub. Doc. Paper; 6x9 in.; pp. 19; 5 text illustrations.

RATING LOCOMOTIVES—By H. L. Cole (District Locomotive Superintendent, Indian State Railways; Assistant Secretary, Railway Board). London: W. Thacker & Co., 2 Creed Lane, E. C. Calcutta and Simla: Thacker, Spink & Co. Stiff morocco; 5x7½ in.; pp. 80; 23 charts; (13 in pocket of cover). 10/6, net; American price, $4.20, net.

REFRIGERATION, COLD STORAGE AND ICE MAKING—A Practical Treatise on the Art and Science of Refrigeration. With which is incorporated "Refrigerating and Ice-Making Machinery." By A. J. Wallis-Taylor, C. E., Assoc. M. Inst. C. E.; Author of "The Pocket-Book of Refrigeration and Ice-Making," etc.; Third edition, thoroughly revised. New York: D. Van Nostrand Co. London: Crosby Lockwood & Son. Cloth; 5½x9 in.; pp. xxiii-632; 414 text illustrations. $4.50, net.

THE RENAISSANCE IN ITALY, FRANCE AND ENGLAND—By F. M. Simpson, Architect; Professor of Architecture in the University of London; F. R. I. B. A.; Sometime Professor of Architecture in the University of Liverpool; Royal Academy Traveling Student, 1884. Being Vol. III of "A History of Architectural Development." New York and London: Longmans, Green & Co. Cloth; 5¾x9½ in.; pp. 359; 268 text illustrations. $6, net.

REORGANIZATION OF THE SYSTEM OF GARBAGE COLLECTION—By Robert E. Goodell. Prepared under the direction of B. M. Rastall. Published semi-monthly. Milwaukee, Wis.: Bureau of Economy and Efficiency, Bulletin No. 12, Jan. 15, 1912. Paper; pp. 24; four tables.

THE SEWERAGE OF SEA COAST TOWNS—By Henry C. Adams, Assoc. M. Inst. C. E., M. I. Mech. E., etc.; Consulting Engineer. New York: D. Van Nostrand Co. London: Crosby Lockwood & Son. Cloth; [illegible]x8¾ in.; pp. 134; 44 text figures. [illegible] net.

STATE BOARD OF HEALTH OF MICHIGAN—Annual report of the secretary [Frank W. Shumway] for year ending June 30, 1910. Lansing, Mich.: Pub. Doc. Cloth; 6¼x9¼ in.; pp. 171; illustrated.

STATE OF CONNECTICUT RAILROAD COMMISSIONERS' REPORT — To which are added Statistical Tables compiled from Annual Reports of the Steam Railroad and Street Railway Cos. of the State for year ended June 30, 1911. Hartford, Conn.: Pub. Doc. No. 13. Cloth; 6x9 in.; pp. 206; two maps in pockets of cover.

STATE INSPECTORS OF HEALTH OF MASSACHUSETTS — Fourth Annual Report of the Work from Nov. 1, 1909-1910. By William C. Hanson, M. D., Assistant to the Secretary of the Board (Mark W. Richardson, M. D.) Reprinted from the 42nd Annual Report of the State Board of Health. Boston, Mass.: Pub. Doc. Paper; 5¾x9 in.; pp. 120; illustrated.

STATE OF RHODE ISLAND RAILROAD COMMISSIONER—Annual report for year ending Dec. 31, 1911, made to the General Assembly at its January session, 1912. Providence, R. I.: Pub. Doc. Cloth; 6x9 in.; pp. 175.

THE STERILIZATION OF WATER SUPPLIES BY THE USE OF HYPOCLORITES—A Paper Presented to the Santa Barbara Meeting League of California Municipalities, Oct. 26, 1911. [With Bibliography.] By Charles Gilman Hyde, Sanitary and Hydraulic Engineer. Berkeley, Calif.: The Author, University of California. Paper; 6x9 in.; pp. 44.

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